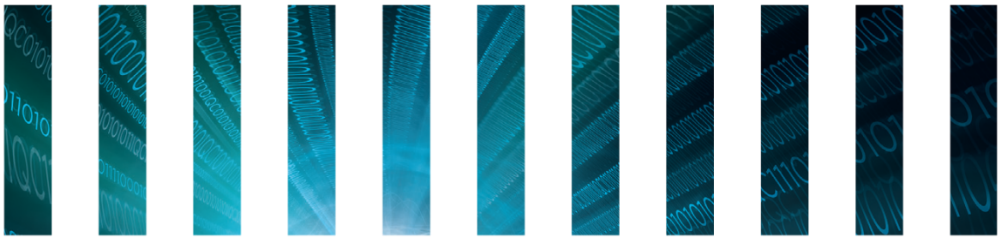


IQC.UWATERLOO.CA

UNIVERSITY OF WATERLOO | IQC Institute for Quantum Computing

INSTITUTE FOR QUANTUM COMPUTING
ANNUAL REPORT
APRIL 1, 2015 – MARCH 31, 2016

SUBMITTED TO:
THE MIINISTRY OF INNOVATION, SCIENCE AND ECONOMIC DEVELOPMENT
JULY 30, 2016

FROM THE EXECUTIVE DIRECTOR

The road from curiosity to commercialization

Since establishing the Institute for Quantum Computing in 2002, I have had the privilege to have a front row seat to its growth and success. I am continually humbled by the response to our collective efforts - from the generous support of our partners, in particular the Government of Canada, to industry representatives to research colleagues from every corner of the globe.

Attracting the highest calibre researchers to Canada remains a top priority for us. This past year, we were delighted to welcome three new members to our faculty community – Vern Paulsen from the University of Houston, Wei Tsen from Columbia University and Na Young Kim from Stanford University. These new members are in addition to William Slofstra from the University of California – our newest research assistant professor.

These new researchers joined our current faculty members, students and postdoctoral fellows generating and sharing quantum information research with the world. We contributed to global knowledge through published papers, presentations at conferences, collaborative projects, outreach initiatives and earned media. Through scientific visitors alone, IQC touched 94 different research institutions in over 20 countries.

All of these efforts have stemmed, in some way, from curiosity: the curiosity to learn more about how the world behaves at its most fundamental level. This curiosity has led to new knowledge and new technologies. IQC is already the birthplace of over 40 patents and five spinoff companies and this year, we are excited to announce that we have begun development on a new industry affiliate program that will help to bridge researchers with the resources to help them make the transition from curiosity to commercialization.

I am excited by the opportunities that continue to emerge from our research and how quickly new ideas are moving toward commercialization. I am delighted that the Government of Canada is our partner in this exciting journey and we will continue to drive innovation for Canada.

Sincerely,

Raymond Laflamme
Executive Director
Institute for Quantum Computing
University of Waterloo

Table of Contents

EXECUTIVE SUMMARY 4
ABOUT THE INSTITUTE FOR QUANTUM COMPUTING 6
FUNDING OBJECTIVES 2014-2017 7
Objective A 8
Objective B 30
Objective C 38
Objective D 41
Objective E 50
APPENDICES 51
A. Risk Assessment & Mitigation Strategies 51
B. Financial Information 52
C. Publications 53
D. Faculty Members and Research Assistant Professors 61
E. Collaborations 62
F. Postdoctoral Fellows 65
G. Graduate Students 66
H. Invited Talks and Conference Participation 68
I. Seminars and Colloquia 81
J. Scientific Visitors 83
K. Tours – Industry, Government and Academic 88
L. Earned Media 90
M. Governance 112
N. Administrative Staff 120

EXECUTIVE SUMMARY

Quantum information research is already leading to the development of new technologies that will transform our world…and the Institute for Quantum Computing (IQC) at the University of Waterloo holds Canada's leadership position in quantum information science and technology research. Each year, great strides are made in quantum information research to develop technologies that will change society at every level – and this year was no different.

Below are highlighted achievements in 2015-16 for each of IQC's five funding objectives, as agreed to with the Government of Canada:

A. **Increase knowledge in quantum information science and technology (Increase in knowledge in the various fields and sub-fields of quantum information, thereby positioning Canadians at the leading edge of quantum information research and technology).**
   This year researchers continued IQC's aggressive research agenda and made advancements in quantum computing, quantum communications, quantum sensors and quantum materials. Collectively, they published 132 papers in world-leading journals and their cumulative citations reached almost 20,000. In addition, IQC successfully recruited three new faculty members and one new research assistant professor.
   - Vern Paulsen, Faculty Member in mathematics from the University of Houston
   - Wei Tsen, Faculty Member in the Department of Chemistry from Columbia University
   - Na Young Kim, Faculty Member in electrical and computer engineering from Stanford University
   - William Slofstra, Research Assistant Professor, from the University of California

B. **Create new opportunities for students to learn and apply new knowledge to the benefit of Canada, spurring innovation, and investment in R&D activities through highly qualified personnel development.**
   IQC is currently home to 116 graduate students and 41 postdoctoral fellows – of these, 12 PhD students, 20 Master's students and 12 postdoctoral fellows were recruited this year after fielding 234 applications from graduate students and 89 for prospective fellows. In line with creating a community of engagement for researchers, IQC also hosted four major conferences, three workshops, 35 seminars and 13 colloquia this year, in addition to sponsoring 14 external conferences.

C. **Brand Canada as the destination of choice for conducting research in quantum technologies and attract the best in the world to Canada, creating partnerships with the international quantum information community and**

promoting a world-class excellence in quantum information science and technology.

IQC's researchers participate in diverse collaborative projects with researchers and organizations across the globe. This year, researchers collectively participated in or attended 140 external conferences and welcomed 157 scientific visitors from 94 different institutions from around the world at IQC.

D. Enhance and expand the Institute's public education and outreach activities to effectively promote science and quantum information science and demonstrate how the research from quantum information science can be applied for the purpose of sustaining and attracting world-class talent.

This year IQC hosted two major summer schools: USEQIP and QCSYS, three Quantum Frontiers Distinguished Lectures, a public lecture, a major Open House event and partnered to create an exhibition for the International Year of Light, attracting over 40,000 attendees. The IQC communications team continued to produce award-winning publications and grow IQC's presence online and in earned media.

E. Position Canada to take advantage of economic and social benefits of research through seizing opportunities to commercialize breakthrough research.

IQC researchers submitted at least four patent applications this year, bringing the current total to 41. With five spinoff companies established to date, IQC also began development of a new Industry Affiliate Program to help bridge researchers with industry for future initiatives.

Overall, the 2015-16 year continued IQC's tradition of research excellence and engaging scientific outreach programming.

ABOUT THE INSTITUTE FOR QUANTUM COMPUTING

IQC was created in 2002 to seize the potential of quantum information science for Canada. IQC's vision was bold: position Canada as a leader in research and provide the necessary infrastructure for Canada to emerge as a quantum research powerhouse. Today, IQC stands among the top quantum information research institutes in the world. Leaders in all fields of quantum information science come to IQC to conduct research, share knowledge and encourage the next generation of scientists.

IQC is leading the next great Canadian technological revolution – the quantum revolution. Quantum technologies and applications developed in IQC labs create the foundation for next generation technologies based on quantum information research conducted right here in Canada.

None of this would be possible without the visionary leadership and investments of Mike and Ophelia Lazaridis, the Government of Canada, the Government of Ontario and the University of Waterloo. This strategic private-public partnership has accelerated the advancement of quantum information research and discovery, not only in Canada, but around the globe.

Vision & Mission

IQC's vision is to harness the power of quantum mechanics for transformational technologies that benefit society and become the new engine for economic growth in the 21st century and beyond.

IQC's mission is to develop and advance quantum information science and technology at the highest international level through the collaboration of computer scientists, engineers, mathematicians and physical scientists.

Strategic Objectives

IQC is guided by three strategic objectives developed in partnership with the Ministry of Innovation, Science and Economic Development:

1. To establish Waterloo as a world-class centre for research in quantum technologies and their applications.
2. To become a magnet for highly qualified personnel in the field of quantum information.
3. To be a prime source of insight, analysis and commentary on quantum information.

FUNDING OBJECTIVES 2014-2017

IQC has been awarded $15M over three years through the generous support of the Government of Canada. This funding will serve to support the following five objectives:

A. Increase knowledge in quantum information science and technology (Increase in knowledge in the various fields and sub-fields of quantum information, thereby positioning Canadians at the leading edge of quantum information research and technology).
B. Create new opportunities for students to learn and apply new knowledge to the benefit of Canada, spurring innovation, and investment in R&D activities through highly qualified personnel development.
C. Brand Canada as the destination of choice for conducting research in quantum technologies and attract the best in the world to Canada, creating partnerships with the international quantum information community and promoting a world-class excellence in quantum information science and technology.
D. Enhance and expand the Institute's public education and outreach activities to effectively promote science and quantum information science and demonstrate how the research from quantum information science can be applied for the purpose of sustaining and attracting world-class talent.
E. Position Canada to take advantage of economic and social benefits of research through seizing opportunities to commercialize breakthrough research.

Through the activities planned and undertaken with the contribution of the Government of Canada in the past year (2015-2016), IQC is well on the way in positioning Canada to take advantage of economic, social, and in some cases, environmental benefits of quantum research.

What follows is a summary of the eligible activities accompanied by the respective progress achieved in the 2015-2016 year.

Objective A

Increase knowledge in quantum information science and technology (Increase in knowledge in the various fields and sub-fields of quantum information, thereby positioning Canadians at the leading edge of quantum information research and technology).

Expected Outcomes for 2015-2016:

- Continue IQC's aggressive research agenda in quantum computation, quantum communication, quantum sensors and quantum materials.
- Recruit up to two new faculty members.
- Recruit up to one new research assistant professor.
- Continue to publish research results in world–leading journals.
- Continue to outfit labs in the Mike & Ophelia Lazaridis Quantum-Nano Centre as new IQC members are recruited.
- Continue to outfit and maintain the Quantum NanoFab facility to enable fabrication of quantum-enabled technologies.
- Update and maintain lab space in Research Advancement Centre (RAC) buildings.
- Continue effective and relevant relationships with current partners. Seek out new partnerships that will advance IQC's mission and strategic objectives.

Highlighted Results for 2015-2016

- Continued research agenda and made advancements in quantum computing, quantum communications, quantum sensors and quantum materials
- Researchers collectively published 132 papers in world-leading journals and cumulative citations reached almost 20,000
- Recruited three new faculty members and one new research assistant professor

Progress Achieved for 2015-2016

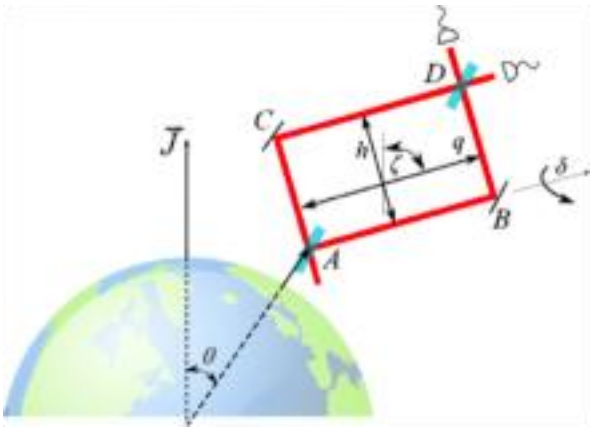
Continue IQC's aggressive research agenda in quantum computation, quantum communication, quantum sensors and quantum materials.

Each year, IQC pursues an aggressive research agenda in quantum computation, quantum communication, quantum sensors, and quantum materials and produces world-leading knowledge in all these areas. In fiscal 2015-2016, IQC researchers collectively published 132 papers (a full list of citations can be found on page 53). Following are select research highlights from this year:

Detecting quantum effects bring satellite experiment one-step closer to feasibility *Physical Review D, http://journals.aps.org/prd/abstract/10.1103/PhysRevD.91.064041*

IQC postdoctoral fellow Aharon Brodutch collaborated with colleagues from the University of Waterloo and Macquarie University, Australia, to determine the set-up of a satellite experiment that detects gravitational effects on the quantum degrees of freedom of a photon.

The researchers considered a theoretical interferometer in space to find the measurement precision needed to detect the effect of gravity on a photon traveling along a beam of light. Using one satellite and two different paths of light rays going to the satellite using time delays, they found that in terms of polarization the gravitational effect is too small to be measured with an interferometer.



Experimental setup: in the Earth-centered inertial frame the z axis is directed along the Earth's angular momentum $\vec{J}$. An interferometer is positioned in the xz plane and oriented at an angle ζ with respect to the z axis. The arms AB and CD have a length q and are perpendicular to the direction of g for ζ ¼ π=2 þ ϑ. The arms AC and BD have length h.

The next theoretical experiment considered a phase-shift in the interferometer. Instead of looking at polarization, the focus was on the phase of the photon going through two different arms. In this experiment for a realistic satellite mission, Brodutch and collaborators found that a phase difference is measureable. After accounting for realistic problems, such as the movement of the satellite and other relativistic effects, the theoretical experiment is extremely close to practical implementation. *Post-Newtonian gravitational effects in optical interferometry*, the third paper in this series, appeared in *Physical Review D* in March 2015.

Violation of the Strong Huygens' Principle and Timelike Signals from the Early Universe *Physical Review Letters, http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.114.141103*

IQC Research Assistant Professor, Eduardo Martín-Martinez, with collaborators from Spain and the Netherlands have shown that information transmitted through echoes – any interaction of matter with a massless quantum field that produces a perturbation – travels more resiliently than it would by light, only showing signs of decay over time. Remarkably, they also showed that, in a matter-dominated universe, the information does not decay at all as a function of distance between the sender

and receiver. Echoes traveling from the very start of the universe could shed some light on this event, providing helpful insight for cosmologists.

According to Martin-Martinez, information about background signals from the early universe will also be propagated through this echo. The challenge now is to figure out precisely what form the echoes will take and how to build receivers that can pick them up. The fundamental results, *Violation of the Strong Huygen's Principle and Timelike Signals from the Early Universe*, appeared in *Physical Review Letters* April 7 2015.

Generic emergence of classical features in quantum Darwinism

Published in Nature Communications,
http://www.nature.com/ncomms/2015/150812/ncomms8908/full/ncomms8908.html

Understanding how the macroscopic classical world emerges from the microscopic quantum world is a fascinating topic that has been puzzling scientists since the early days of quantum mechanics. This "quantum-to-classical" transition is important both conceptually and for the future of quantum computing. We need to know, for example, if a 1,000-qubit quantum computer can maintain the quantum features necessary to process quantum information.

New research from IQC Research Assistant Professor Marco Piani and collaborators shows for the first time that the emergence of classical objectivity, as described by the quantum Darwinism framework, is actually a direct consequence of the laws of quantum mechanics itself.

Two elements of quantum Darwinism include the objectivity of observables, which states that the environment selects the same specific classical information to be made potentially available to all observers, and the objectivity of outcomes, which states that the observers will have access to the outcome of the observation and agree on it.

The paper *Generic emergence of classical features in quantum Darwinism* proves that the objectivity of observables is completely general and always present, independent of the interaction between the system and its environment. Piani and collaborators found that the objectivity of outcomes, however, is model-dependent and does depend on the type of interaction between the system and its environment. Piani, now at the University of Strathclyde, says, "Future work will focus on the assumptions required to ensure the objectivity of outcomes."

In addition to the significant research progress in quantum Darwinism, the paper also derived a clear-cut operational meaning for quantum discord, which is a measure of non-classical correlations between two subsystems of a quantum system. The researchers found that when one share of the correlations between two parties is

redistributed to many parties, quantum discord is equal to the minimum average loss of correlations.

The paper, co-authored by Fernando G.S.L. Brandão (Microsoft Research, University College London) and Pawel Horodecki (National Quantum Information Center of Gdańsk, Technical University of Gdańsk), appeared in Nature Communications August 12. It exemplifies how modern techniques of quantum information can find applications in many other fields of physics, including the foundations of physics. Understanding the quantum-to-classical transition will also lead to improved technological control over quantum features, which may be helpful for future implementation of quantum technologies.

Controlling Quantum Devices with Nonlinear Hardware

Published in Physical Review A, http://journals.aps.org/prapplied/abstract/10.1103/PhysRevApplied.4.024012

Design of a quantum device sometimes requires a compromise between the complexity of the control hardware and its overall efficiency of controlling the quantum system. A team of researchers has developed a general framework that will minimize this compromise, leading to faster quantum logic gate times and lower error rates in certain implementations to minimize the impact of the imperfection of the control hardware.

Control hardware is usually designed to minimize distortions that classical electronics introduce to control pulses as they are sent to quantum systems. This can limit the capability and performance of the hardware. The new framework proposes a practical way to account for distortions and still yield precise and robust quantum control – even if the distortions are nonlinear and noninvertible. As an example, they performed a numerical demonstration of the robust control of a qubit with a strongly-driven superconducting resonator. The next step will be to demonstrate that this technique is useful experimentally to create practical robust quantum devices.

The paper, *Controlling Quantum Devices with Nonlinear Hardware* by IQC researchers Ian Hincks, Troy Borneman and David Cory, and IQC alumnus Christopher Granade, now at the University of Sydney appeared in Physical Review Applied in August.

Single pairs of time-bin entangled photons

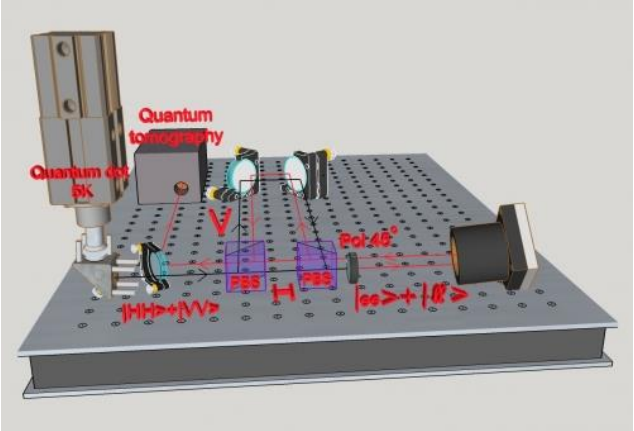
Published in Physical Review A, *http://arxiv.org/pdf/1507.01876v1.pdf*

An international team of researchers, including IQC faculty member Michael Reimer, has developed the first source of on-demand single time-bin entangled photon pairs with no possibility of producing extra unwanted pairs. Ensuring that only a single pair is produced may lead to increased security in quantum communication, improved

transfer of quantum information and advances in the development of compact and scalable quantum information devices.

Quantum communication networks often rely on polarization entangled photons, strongly correlated quantum particles to transmit quantum information through an optical fibre. The polarization-entangled photons are vulnerable to thermal and mechanical disturbances in the fibre – this causes the photons to lose entanglement over long distances and disrupt the network. Unlike polarization entangled photons, time-bin entangled photons are not affected by these disturbances in the fibre, which makes time-bin entanglement ideal for robust transfer of quantum information over long distances.

Reimer, a faculty member with the Department of Electrical and Computer Engineering at the University of Waterloo and collaborators at the Technical University of Delft created a source of on-demand single time-bin entangled photon pairs. The team used a quantum dot – a nano-sized object containing thousands of semiconductor atoms – to generate single pairs of polarization entangled photons on-demand, emitted only when triggered by a laser pulse. Next the photon pairs were sent through an interferometer to convert to time-bin entanglement.



Set-up based on a quantum dot and a polarization-time-bin interface. Single polarization entangled photon pairs from the quantum dot are converted into single time-bin entangled photon pairs.

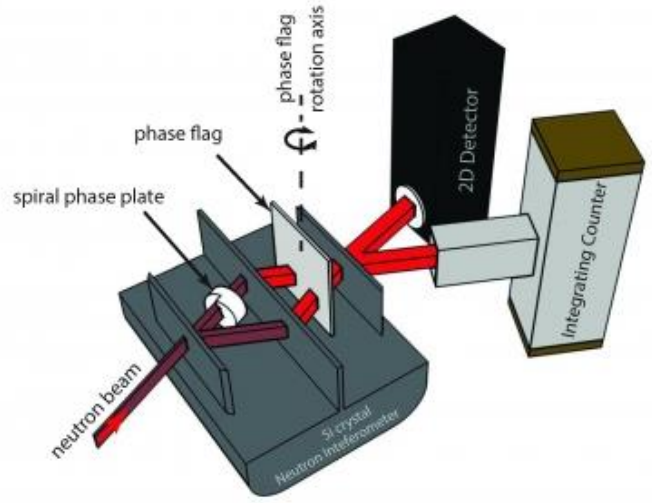
This new optical approach to generate time-bin entanglement developed by Reimer and collaborators opens up other possibilities for future research, including spin-photon entanglement distribution, entanglement purification and more. Currently, the conversion process requires a bulky laser and large optical set-up. "It's possible to embed the quantum dot into a semiconductor device and operate it electrically – then only a compact, nano-sized device would generate the time-bin entangled photons," Reimer notes. The paper *Single pairs of time-bin entangled photons* appeared in *Physical Review A* on September 4, 2015.

Controlling neutron orbital angular momentum

Published in Nature,
http://www.nature.com/nature/journal/v525/n7570/full/nature15265.html

An experiment by a team of researchers led by IQC shows, for the first time, that a wave property of neutrons, Orbital Angular Momentum (OAM), can be controlled by any specified value. This newfound control of neutron OAM states means that researchers can now use neutron OAM beams to see inside materials that optical, x-ray or electron OAM beams can't penetrate. This control can help measure the magnetism, for example, in magnetic materials, as well as enable deeper probes of superconducting and chiral materials.

Research Assistant Professor Dmitry Pushin, a member of the Department of Physics and Astronomy at the University of Waterloo, and collaborator Charles Clark of the Joint Quantum Institute in Maryland conceived of the idea to control neutron OAM. Pushin designed the experiment that uses neutrons created by a nuclear reactor at the National Institute of Standards and Technology (NIST) and passes them through a Mach-Zehnder interferometer.

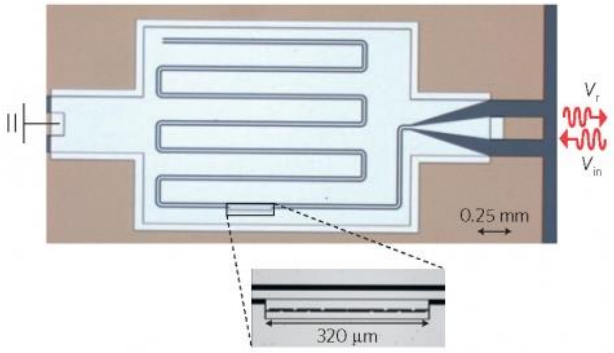


The interferometer for testing orbital angular momentum for neutrons.

Probing the quantum vacuum with an artificial atom in front of a mirror

Published in Nature Physics,
http://www.nature.com/nphys/journal/v11/n12/full/nphys3484.html

The concepts of a quantum vacuum and quantum vacuum fluctuations are still not accepted by everyone. However, a group of researchers, including IQC's Christopher Wilson, have found further evidence that the two concepts are a reality. Through experiments conducted at Chalmers University of Technology, the researchers were able to probe the quantum vacuum fluctuations and not only measure their strength, but also map out their shape.



An artificial atom in front of a mirror. A micrograph of the atom–mirror system, a superconducting transmon embedded at a distance L from the end of a one-dimensional transmission line. Zoomed-in view: the transmon. The atom size is small compared with the wavelength of the microwave field. We characterize the system by sending in a coherent probe field, Vin, at ωp ≈5GHz and measuring the reflected field, Vr . Measurements are performed at T=50 mK, where thermal excitations of the field are negligible. b, Cartoon of the atom–mirror system. The blue and red curves show the mode structure of the voltage along the transmission line at the atom frequency for L=λ/2 and L=3λ/4, respectively. By tuning λ of the two-level atom through an external magnetic flux, Φ, the coupling between the field and the atom can be turned o when the atom sits at a node of the resonant electromagnetic field (blue). The atom is maximally coupled at the antinode (red).

Using a mirror, the researchers were able to engineer the vacuum to reduce the fluctuations that in turn, control the vacuum modes, or give the fluctuations a well-defined shape. In many situations, the vacuum fluctuations limit the coherence, or lifetime, of a qubit – in this case a superconducting artificial atom. If there were no vacuum fluctuations to cause the decay of the atom, it would stay in the excited state. Studying the lifetime of the atom therefore allowed Wilson and colleagues to probe the vacuum fluctuations.

"This is important from a quantum computing aspect," said Wilson, an associate professor in both the electrical and computer engineering and the physics and astronomy departments at the University of Waterloo. "By figuring out different ways to shape and control the vacuum fluctuations, it's a step towards the goal of developing quantum technologies." The paper, *Probing the quantum vacuum with an artificial atom in front of a mirror*, was published in *Nature Physics*, September 2015.

Quantum Hilbert Hotel

Published in Physical Review Letters,
http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.115.160505#fulltext

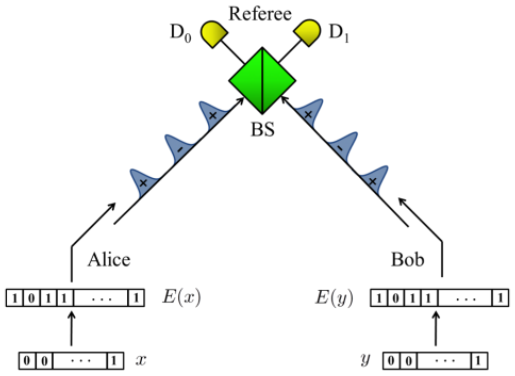
Mathematician David Hilbert proposed the Hilbert Hotel Paradox thought experiment in 1924 to demonstrate infinity – the mathematical notion of no limits. Researchers from the universities of Strathclyde, Glasgow, Rochester, Ottawa and IQC associated the rooms of the Hilbert Hotel with quantum states and then looked for a way to vacate every second level, given that a quantum system that has an infinite amount of quantum states.

IQC postdoctoral fellow Filippo Miatto proposed the use of Orbital Angular Momentum (OAM) states of light to implement the Hilbert Hotel protocol. OAM is associated with the rotation of an object around a fixed axis and in the case of a light beam to the rotation of the optical phase around the direction of propagation.

By showing that they could physically realize the Hilbert Hotel Paradox, the researchers also found that they could perform deterministic non-linear interactions on the OAM by pre-sorting and then applying distinct Hilbert Hotel operation to the distinct OAM components. This result opens new possibilities for quantum information and computation operations. *Physical Review Letters* published the results in the paper *Quantum Hilbert Hotel* in October.

Experimental quantum fingerprinting with weak coherent pulses

Published in Nature Communications,
http://www.nature.com/ncomms/2015/151030/ncomms9735/full/ncomms9735.html



IQC researchers Norbert Lütkenhaus, Juan Miguel Arrazola and Shihan Sajeed, in collaboration with researchers from the group of Professor Hoi-Kwong Lo at the University of Toronto, experimentally demonstrated a quantum fingerprinting system that can transmit less information than the best-known classical protocol.

In this problem, Alice and Bob receive inputs and based on these inputs, they send a message to a third party – the referee. The referee uses this received information to determine whether the inputs to Alice and Bob are equal, and the goal is to do this by transmitting as little information as possible. By modifying a version of a commercial Quantum Key Distribution (QKD) system using optical components, the researchers were able to transmit messages up to 100 Mbits with 66% less information than the best known classical protocol over a five-kilometre standard fibre operating at telecom wavelengths. *Nature Communications* published the results *Experimental quantum fingerprinting with weak coherent pulses* in October 2015.

A schematic illustration of the quantum fingerprinting protocol. Alice and Bob receive inputs x and y, respectively, which they feed to an ECC to produce the codewords E(x) and E(y). Using these codewords, they modulate the phases of a sequence of coherent pulses that they send to the referee. The incoming signals interfere at a beam splitter (BS) and photons are detected in the output using single-photon detectors D0 and D1. In an ideal implementation, detector D1 fires only when the inputs to Alice and Bob are different.

A strong loophole-free test of local realism

Published in Physical Review Letters, http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.115.250402

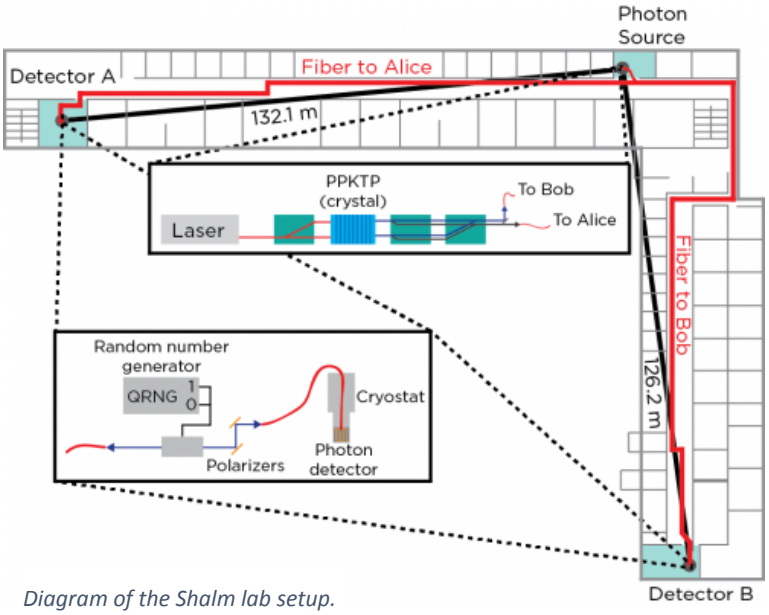


Diagram of the Shalm lab setup.

Researchers in Canada, the United States and Europe led by the National Institute of Standards and Technology in Boulder, Colorado and IQC alumnus Krister Shalm have ruled out classical theories of correlation with remarkably high precision. A group including IQC members Evan Meyer-Scott, Yanbao Zhang, Thomas Jennewein and alumnus Deny Hamel built and performed an experiment that shows the world is not governed by local realism.

Local realism states that the world is predictable and only influenced by its immediate surroundings. Almost 30 years after this thought experiment, work by John Bell allowed scientists to experimentally test the hypothesis that nature is governed by local realism through measuring entangled particles to find the strength of their correlations. Due to technological limitations, work by John Bell allowed scientists to experimentally test the hypothesis, but they had to make additional assumptions to show local realism

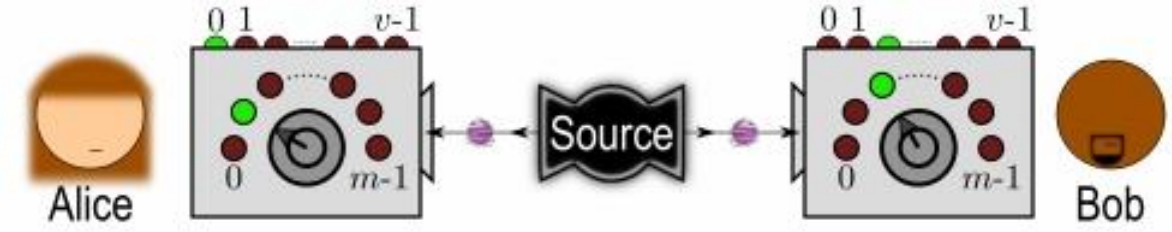
was incompatible with their experimental results opening three possible loopholes – locality, freedom-of-choice and fair-sampling.

With new detectors built by NIST and a new high-performance photon source, researchers now have the technology needed to perform the Bell test closing all three loopholes simultaneously. The paper, *A strong loophole-free test of local realism*, appeared in *Physical Review Letters* in December. The results could have great significance for device-independent quantum communication.

Identifying nonconvexity in the sets of limited-dimension quantum correlations

Physical Review A,
http://journals.aps.org/pra/abstract/10.1103/PhysRevA.92.062120

IQC PhD student John Donohue, along with Elie Wolfe from the Perimeter Institute of Theoretical Physics, has determined the required complexity of a quantum system and how many bits of shared classical information are needed between two parties to generate a general probability distribution with a known set of correlations.



In a device-independent setting, two parties named Alice and Bob, obtain some output after setting a dial to their desired input. This description avoids assumptions about the internal physics of their devices, yet can still be used to verify genuine non-classical (for example, quantum) behaviour through simply the correlation of their outputs.

Taking a device-independent perspective, without making any assumptions about experimental execution such as measurement devices or other variables, the pair of researchers investigated theoretical quantum systems with a restricted set of inputs and outputs. They looked at how much shared randomness – the length of a shared string of bits or classical information – between two parties is required for the system to fill out the set of quantum correlations. Characterizing this set of possible correlations is useful in classifying what tasks can be done using classical physics and what tasks need quantum resources.

In a simple case where Alice and Bob can each choose one of two inputs and reveal one of two possible outputs, Donohue and Wolfe found that at most three bits of shared randomness are required to reach the full set of achievable quantum correlations with a two-qubit system. Without this shared randomness, the range of

possible quantum correlations is nonconvex, meaning that even if two types of correlation are possible to build, their average may not be. This is the first time that nonconvexity has been shown for complete regions of quantum correlations.

These results may be useful for entanglement verification and opens the door to further research in this area. “Many questions remain,” says Donohue, “including the consideration of more complex scenarios with additional qubits.”

Certifying the presence of a photonic qubit by splitting it in two

Physical Review Letters,
http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.116.070501

A team led by researchers from IQC and the Department of Physics and Astronomy at the University of Waterloo has successfully detected the presence of single photons while preserving their quantum states.

In quantum communication, photons in quantum states are used as carriers of information and sent over long distance, for applications like quantum cryptography and teleportation. However, any transmission is inherently lossy – only 50 per cent of photons arrive after travelling 15 kilometres through optical fibre – making it very difficult to know when an individual photon is arriving. Using a nonlinear optical process called parametric down-conversion applied to incoming single photons, the team demonstrated photonic qubit precertification for the first time, certifying the presence of the photons without destroying their quantum states.

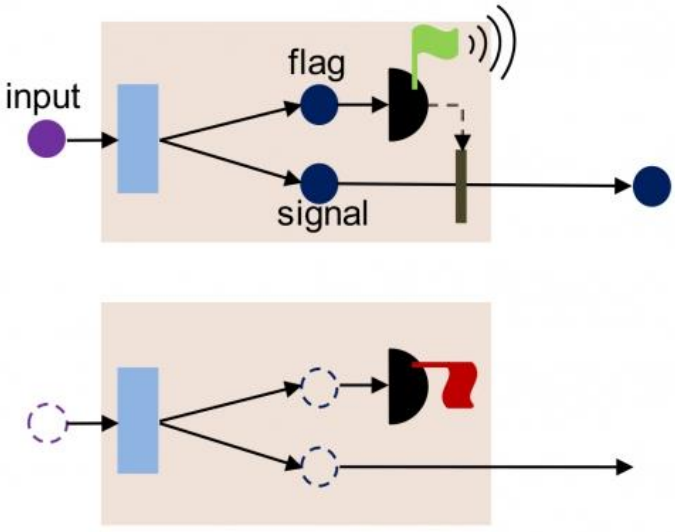


Diagram of the photon being split and received.

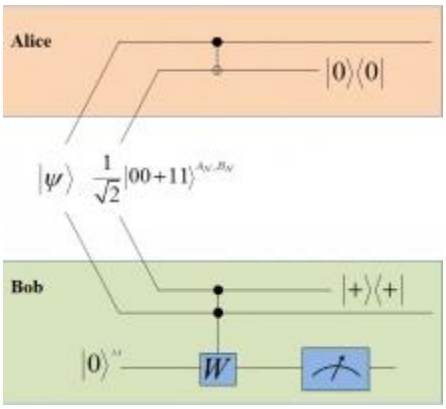
“This is an important result in the field of quantum communication,” said IQC researcher and PhD candidate in the Department of Physics and Astronomy at the University of Waterloo Evan Meyer-Scott. “Many cutting-edge protocols rely on knowing that a photon is present.”

The paper, *Certifying the presence of a photonic qubit by splitting it in two*, was published February 16, 2016 in *PRL*.

Non-local Measurements via Quantum Erasure
Physical Review Letters,
http://journals.aps.org/prl/abstract/10.1103/PhysRevLett.116.070404

IQC postdoctoral fellow Aharon Brodutch and Eliahu Cohen (Tel Aviv University, University of Bristol) have developed a new method for designing complex quantum measurements. The researchers looked specifically at projective measurements – measurements that project the state of the system into a new state corresponding to the result. For example, when measuring spin, if the spin was 'up' and the resulting measurement is 'up', the spin remains 'up'.

Brodutch and Cohen used the von Neumann measurement scheme and a quantum eraser to model a measurement that requires specific interactions between two physical systems that are challenging to construct. Brodutch and Cohen presented a protocol for carrying out non-local measurements – projective measurements of observable quantities on a system with parts at different locations. First, they performed simpler measurements that revealed too much information about the system and then erased parts of the results. The local measurement is erased, or undone, by making a conjugate, or incompatible, measurement and post-selecting the result.



In a non-local parity measurement of a quantum system shared between two distant observers, the observers want to know if their local states are correlated or anti-correlated with each other, without learning their specific values.

The protocol Brodutch and Cohen present shows that it is possible to erase the unwanted local information while retaining the desired parity information, turning the local measurements into non-local ones.

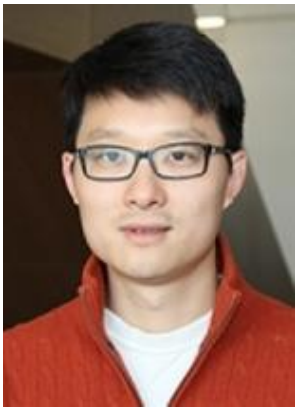
The new protocol could be useful for other projective measurements on systems that cannot interact directly with each other, or in generating photon interactions or quantum gates for quantum computation. The results, *Non-local Measurements via Quantum Erasure*, appeared in *Physical Review Letters* February 18 2016.

Recruiting New Researchers:
Recruit up to two new faculty members and one research assistant professor.

Attracting and retaining highly qualified personnel remains a priority and IQC continues efforts to recruit world-leading theoretical and experimental researchers in a range of disciplines from around the world. IQC is proud to report that this year, three new faculty were recruited, as well as one new research assistant professor (RAP). The entire IQC community is proud to welcome Vern Paulsen, Wei Tsen and Na Young Kim to the faculty community, as well as William Slofstra as the new RAP.

Vern Paulsen joined IQC in July of 2015 as a faculty member in the Faculty of Mathematics and as a member of IQC. He received his PhD in Mathematics from the University of Michigan-Ann Arbor in 1977 and spent two years at the University of Kansas before moving to the University of Houston. In 1996, he became a John and Rebecca Moores Professor in the Department of Mathematics. Vern has written four graduate level texts in mathematics, published over 100 research articles, and won several teaching awards. His mathematical research includes quantum information theory and he has been involved in Quantum Information Technology (QIT) programmes at Sweden's Mittag-Leffler Institute and Cambridge's Isaac Newton Institute.

Na Young Kim joined IQC in March 2016 in the Department of Electrical and Computer Engineering. Previously, she served as a Physical Science Research Associate in Professor Yoshihisa Yamamoto's group at E. L. Ginzton Laboratory, Stanford University. She received her PhD in Applied Physics from Stanford University for her dissertation on Correlated Electron Transport in One-Dimensional Mesoscopic Conductors. She also holds a BS in Physics from Seoul National University. She was a specially appointed researcher at the University of Tokyo and a postdoctoral researcher at Stanford University. She was a recipient of the Outstanding Young Researcher Award in 2012 from the Association of Korean Physicists in America. Her current research interests are to construct solid-state quantum emulators for studying macroscopic quantum phases and to develop novel optoelectronic devices based on exciton-polariton condensates.



Wei Tsen joined the Department of Chemistry and the IQC community in January of 2016 as an Assistant Professor. After receiving a BS in Electrical Engineering and Computer Sciences, as well as a BS in Engineering Physics at the University of California, Berkeley, Wei completed his PhD in Applied Physics at Cornell University under the guidance of Jiwoong Park. He then joined the Department of Physics at Columbia University as a postdoctoral associate with Abhay Pasupathy and Philip Kim, where he studied atomically thin quantum materials and incorporated them in nanoscale

electronic devices. Wei will continue to explore these materials at IQC and develop novel quantum devices based on their exotic properties.

William Slofstra joined IQC in August of 2015 as a Research Assistant Professor. He received his PhD in Mathematics from the University of California, Berkeley in 2011. After spending part of 2012 at the University of British Columbia as a Research Associate, Slofstra returned to California as the Krener Assistant Professor at the University of California, Davis. His research interests have focused on algebra, specifically in Lie theory/representation theory, Schubert calculus and connected areas, as well as non-local games.

The addition of these members brings the total number of current faculty (as of March 31) to 24, positioning IQC well on the way to reaching its goal of 33 members by 2019. A full list of current faculty can be found on page 61.

Continue to publish research results in world-leading journals.

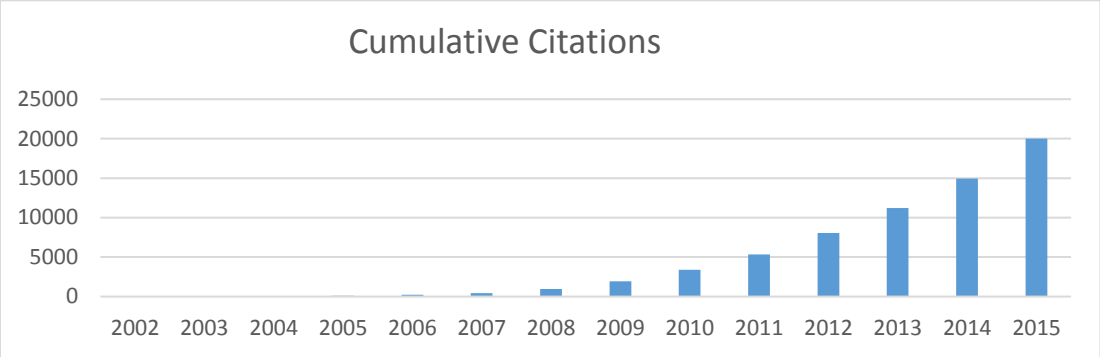
Publications and Citations

One measure of research output taking place at IQC is the number of papers published each year. In 2015-2016, IQC's researchers published 132 papers, reaching international audiences and several were published in prominent scientific publications including, *Nature, Nature Communications* and *Physical Review Letters.* Below is a summary of IQC research published in prominent journals since 2010. A full list of citation for papers published this year can be found on page 53.

IQC Research Published in Prominent Journals Since 2010						
Publication	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
Nature	1	1	1		2	1
Nature Photonics	1	1		3	2	1
Nature Physics	5	3	2	3		2
Nature Communications		1	1	1	5	3
Physical Review Letters	14	17	14	14	16	17
Science	1	2	1	1	3	
STOC	2					
FOCS		1	1			
Journal of Mathematical Physics	2	4	6	4	4	6

In addition to being published in notable journals, the number of citations IQC papers garner is a testament to the quality of research conducted. Since IQC was established and began producing research in 2002, papers published have been

cited by other researchers in papers a total of 19,993 times (as of March 31, 2016). In the past year, this number grew by approximately 1,000 citations per quarter. Below is a chart demonstrating this growth year over year.



Note: *Source for Publications and Citations: Thomson Reuters' Web of Science on April 1, 2016. Data compiled using an address search for Institute for Quantum Computing (inst* quantum comp*). Citations are cumulative for all IQC publications for all years.*

Research Grants

Over the last year, IQC researchers have been collectively awarded $12,143,996 in research funding. These funds include research chair awards, funding from the Province of Ontario, the Government of Canada, the Canada Foundation for Innovation (CFI), industry partners and others. The chart below summarizes levels of funding in each of IQC's fiscal years since 2010.

Fiscal	10-11	11-12	12-13	13-14	14-15	15-16
	$12,169,272	$8,182,135	$10,530,098	$7,201,875	$14,063,316	$12,143,996

Note: *Information on research grants is aligned with the University of Waterloo fiscal year, which falls May 1 – April 30. The 2015-2016 amount reflects only until March 31, 2016.*

Faculty Awards

IQC faculty members are known both nationally and internationally. In addition to the research conducted at IQC being distributed around the world through publications and presentations at conferences, the contributions by IQC's talented faculty are also recognized by external agencies through awards. IQC faculty received the following awards 2015-2016:

Researcher	Award Earned in 2015-2016
Kyung Soo Choi	Early Researcher Award
David Cory	Fellowship of the Royal Society of Canada Fellow, American Physical Society
Raymond Laflamme	Canada Research Chair - Tier I
John Watrous	Outstanding Performance Award, University of Waterloo

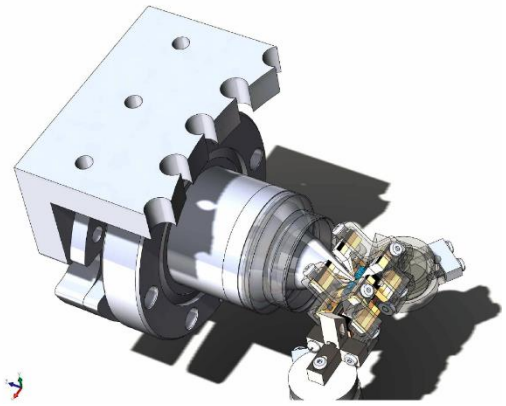
IQC is also home to the following research chairs:

- Raymond Laflamme, Canada Research Chair (Tier 1) in Quantum Information (renewed 2016)
- Debbie Leung, University Research Chair, University of Waterloo (2015)
- Raffi Budakian, WIN Endowed Chair in Superconductivity (2014)
- Kevin Resch, Canada Research Chair (Tier 2) in Optical Quantum Technologies (2013)
- Michele Mosca, University Research Chair, University of Waterloo (2012)
- David Cory, Canada Excellence Research Chair in Quantum Information Processing (2010)
- Richard Cleve, IQC Research Chair (2004)

Continue to outfit labs in the Mike & Ophelia Lazaridis Quantum-Nano Centre as new IQC members are recruited.

Michal Bajcsy and Kyung Soo Choi are the two faculty members to have most recently established lab spaces in the Mike & Ophelia Lazaridis Quantum Nano-Centre. Both joined IQC in the 2013-14 fiscal and have been working since to outfit their respective labs. Each are now fully operational, having procured the equipment and infrastructure reported as planned in last year's report.

In Kyung Soo Choi's Ultracold Quantum Matter and Light Laboratory, additional equipment for measuring quantum gases has been custom designed and built by the research team to enable their work with Rydberg atoms.

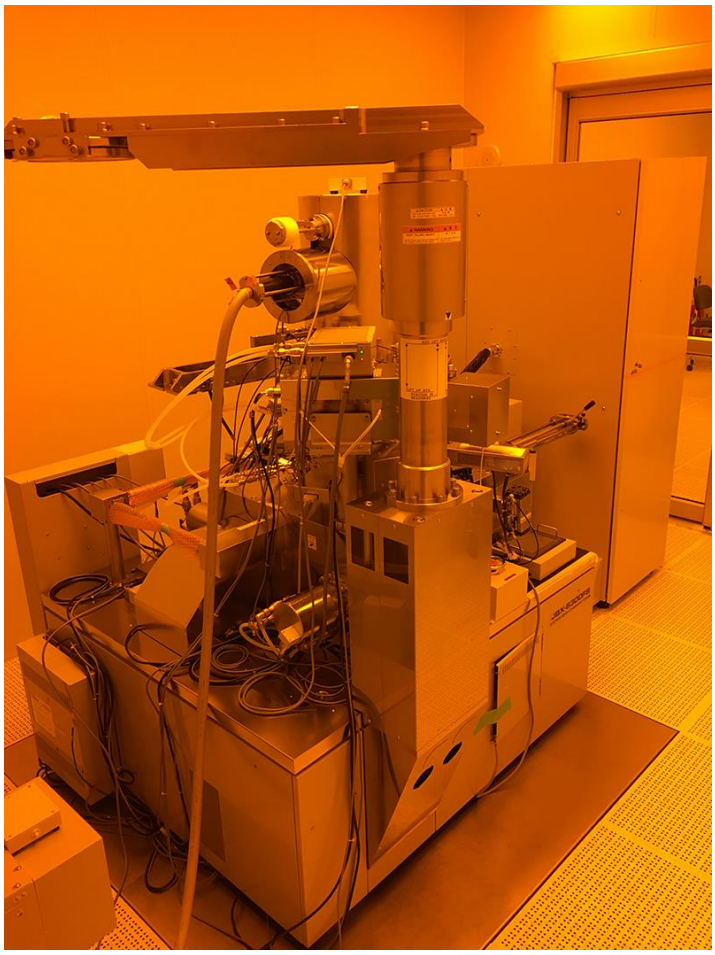


Chamber Cage Cavity

Continue to outfit and maintain the Quantum NanoFab facility to enable fabrication of quantum-enabled technologies.

To date, 145 registered users are trained to use the 8,000 square foot facility housing state-of-the-art equipment to further the research of both IQC and the neighbouring Waterloo Institute for Nanotechnology (WIN). As the use of the facility increases, so has the Quantum NanoFab team. This year saw the addition of an Accounting and Administrative Assistant to allow for more efficient service to facility users.

The most significant piece of equipment procured for the facility this year was a new JEOL E-Beam Lithography System. This new machine, which arrived in March 2016, will extend the current capabilities for patterning structures from 40 nm down to 8 nm (approximately 80 atoms wide). This system could be used to build structures to corral a single electron, for example.



E-Beam Lithography System

Update and maintain lab space in Research Advancement Centre (RAC) buildings.

Continued developments to both Research Advancement Centre buildings (RAC I and RAC II) have taken place through the past year. Two of the three newest faculty members to IQC – Wei Tsen and Na Young Kim – will establish and begin to outfit lab spaces in RAC I in the coming year, while Raffi Budakian and Michael Reimer, who joined IQC in 2014-15, have worked to outfit their labs over the past year.

Since joining IQC, Michael Reimer has been designing and procuring equipment for his lab, including a custom-designed closed-cycle low temperature cryostat that keeps nanowire samples at very low temperatures (as low as 4 degrees Kelvin or –269 degrees Celsius). This is the first of its kind in North America and one of only two

cryostats like it in the world. It will be used for testing tunable quantum light sources and testing integrated photonic circuits. In addition, a pico-second pulse laser was procured (to produce precise a pulse length to generate on-demand photons at the correct wavelength), as were two spectrometers and two optics tables. The lab is expected to be operational early by May 2016.

Michael Reimer has also served to coordinate overall updates in RAC I. For 2015-2016, this includes the introduction of nitrogen service, compressed air, chilled water, temperature and humidity controls and optical fibre running throughout the building to facilitate communication between all labs.

Research Advancement Centres (RAC I and II)

Continue effective and relevant relationships with current partners. Seek out new partnerships that will advance IQC's mission and strategic objectives.

IQC and its researchers highly value opportunities for collaboration, both with other research groups and universities as well as with government, non-profits and industry.

The following list of 82 organizations includes collaborations with one or more IQC faculty members. These relationships span universities, research institutes, industry, government – and the globe. On page 62 find a breakdown of collaborations by researcher.

Approach Infinity Inc., Canada
Brockhouse Institute, McMaster University, Canada
C2C Link Corporation, Canada
Cambridge University, UK
Canadian Institute for Advanced Research (CIFAR), Canada
Canadian Space Agency, Canada
Centre for Quantum Technologies (CQT), National University of Singapore, Singapore
COMDEV Inc., Canada
Communication Security Establishment, Canada
Computational Complexity, Springer Basel AG, Germany
Computational Complexity, Switzerland
Delft University of Technology, The Netherlands
Department of National Defence, Canada
Department of Physics, University of Toronto, Canada
DotFAST
École Polytechnique de Montréal, Canada
Eindhoven University of Technology, The Netherlands
European Telecommunications Standards Institute (ETSI), France
Excelitas (former Perkin Elmer), Canada
Federal University of Ceará, Brazil
Francis Bitter Magnet Laboratory, Massachusetts Institute of Technology, USA
Goodyear, Canada
Government of Canada, Canada
Hefei National Laboratory for Physical Sciences at the Microscale, China
High Q, Canada
ID Quantique, Switzerland
Infinite Potential Group, Canada
Infinite Potential Inc., Canada
InfoSec Global, Canada
Institute for Quantum Science and Technology (IQST), University of Calgary, Canada
Institute for Security, Privacy and Information Assurance, University of Calgary, Canada
Korea Institute of Science and Technology, South Korea
Massachusetts Institute of Technology, USA
McGill University, Canada
MITACS, Canada
Moscow State University, Russia
National Institute of Optics (INO), Canada
National Institute of Standards and Technology (NIST), Canada
National Institute of Standards and Technology (NIST), USA
National Research Council of Canada, Canada
National University of Defense and Technology, China
Natural Sciences and Engineering Research Council of Canada (NSERC) CREATE
Neptec, Canada
Nicolaus Copernicus University in Torun, Poland
Northwestern University, USA

Ontario Centres of Excellence, Canada
Perimeter Institute for Theoretical Physics, Canada
Politecnico di Milano, Italy
Princeton Lightwave, USA
Qingdao University, China
Quantum Investment Funds, Canada
Quantum Valley Investments, Canada
Royal Institute of Technology, Sweden
Schlumberger-Doll Research Laboratory, USA
Security Innovations, USA
SERENE, Canada
Shanghai Center for Complex Physics, China
SignitSure Inc., USA
Stanford University, USA
State Pedagogical University, Russia
Swiss Federal institute of Technology in Zurich (ETHZ), Switzerland
Tech Capital Partners, Canada
Technion – Israel Institute of Technology, Israel
Texas A & M University, USA
Trustpoint, Canada
Tutte Institute for Mathematics and Computing, Canada
Universal Quantum Devices, Canada
Universidad Complutense de Madrid, Spain
Universidad de Valladolid, Spain
Université de Montréal, Canada
University of Calgary, Canada
University of Guelph, Canada
University of Illinois, USA
University of Innsbruck, Austria
University of Maryland, USA
University of Ottawa, Canada
University of Seville, Spain
University of Sydney, Australia
University of Toronto & UTIAS Space Flight Laboratory, Canada
University of Vienna, Austria
University of Vigo, Spain
Xiphos, Canada

Collaborative Profile

An example of a current project with multiple ties to industry, research and government agencies is IQC faculty member Thomas Jennewein's quantum key distribution project. The project's overall goal is to deploy secure long-distance quantum communication via quantum key distribution (QKD) using Earth-orbiting satellites. Jennewein is one of several groups around the world vying to be the first to demonstrate QKD from space. This year, Thomas' group made strides with the successful completion of the development of the Acquisition, Pointing and Tracking (APT) fine pointing systems for a future QKD satellite payload. This was accomplished in partnership with the Neptec Design Group out of Ottawa and the Institut National d'Optique (INO) in Québec City and was supported by funding from Canadian Space Agency (CSA). Jennewein's group also commenced a new project to advance the Detector Assembly subsystem of a QKD satellite payload, under a contract from the CSA and working in collaboration with Neptec and other industrial partners.

In addition, Jennewein and his team worked with Xiphos Technologies in Montréal on another CSA-funded project - Logic and Hybrid Algorithm Acceleration (LAHAA) - that succeeded in significantly speeding up the run-time of the QKD software from 16 minutes to under 30 seconds – a 32 times improvement. Discussions were initiated with the CSA and the National Research Council Canada (NRC) on the potential use of an NRC aircraft to conduct an airborne demonstration of QKD and finally, the project received a grant under the CSA's FAST (Flights and Fieldwork for the Advancement of Science and Technology) program for a new project to demonstrate technologies for quantum communications space networks to enable to continuation of their work.

Seeking New Strategic Partnerships

In addition to maintaining and growing established relationships, IQC stakeholders continuously seek new partnerships to further strategic objectives. This year, IQC initiated relationships with the following groups:

- Defence Research and Development of Canada (DRDC): On May 4-5, IQC hosted twelve representatives from the DRDC to take part in discussions with researchers to explore common areas of interest and research and to generally explore potential collaborations.
- Dutch Delegation: On May 28, IQC was honoured to host Their Majesties King Willem-Alexander and Queen Máxima of the Netherlands to witness the signing of a memorandum of understanding between the University of Waterloo and Delft University of Technology. The new memorandum of understanding will allow for exchange opportunities for students, staff and researchers, collaboration on research projects and the exchange of research publications and reports in quantum information.
- NASA: Over the period of June 1-2, researchers at IQC hosted five representatives from NASA and Paul Kwait's University of Illinois at Urbana-

Champaign group to discuss current research and explore possible opportunities for future partnerships.

- Cybersecurity Symposia: IQC continues to seek partnerships with industry and government on cybersecurity initiatives. To support these partnerships, IQC hosts cybersecurity symposia and this year sessions were held in Toronto on June 2 and in Ottawa on December 1. IQC brought together leaders to discuss the issues and opportunities for Canada's cybersecurity environment and to explore potential collaborative partnerships in a quantum world.

Objective B

Create new opportunities for students to learn and apply new knowledge to the benefit of Canada, spurring innovation, and investment in R&D activities through highly qualified personnel development.

Expected Outcomes for 2015-2016

- Continue to grow and attract the best talent to IQC's graduate program
    - Field at least 200 applications to the University of Waterloo/IQC graduate studies program
    - Attend at least four graduate fairs to connect with prospective students
    - Expand connections made with undergraduate programs at Ontario and Canadian universities
    - Take part in at least two international recruitment events
- Continue to host timely, focused conferences, workshops, seminars and courses
    - Host two major conferences
    - Hold up to 10 workshops and seminars
    - Jointly sponsor up to 10 workshops and conferences with national and international partner organizations

Highlights for 2015-2016

- IQC is currently home to 116 graduate students and 21 postdoctoral fellows
- Recruited 12 new PhD students, 20 new Master's students and 12 postdoctoral fellows
- Fielded 234 applications to IQC programs
- Hosted four major conferences, three workshops, 35 seminars, 13 colloquia and sponsored 14 external conferences

Progress Achieved for 2015-2016

Continue to grow and attract the best talent to IQC's graduate program

Since the spring of 2015, over 234 students applied to IQC graduate programs, surpassing the goal of 200. Of these, 142 applied directly to the collaborative program and the remaining 92 applied to other programs including Computer Science, Applied Mathematics, Combinatorics and Optimization, Electrical and Computer Engineering, Physics and Astronomy or Chemistry and indicated an interest in quantum computing or quantum information.

Attracting Talent and Connections to IQC

In addition, IQC participated in four external graduate fairs across Canada to connect with prospective graduate students.

- University of British Columbia, September 30 – October 1; IQC represented by PhD student, Vadiraj Ananthapadmanabha Rao

- Trent University (Canadian Undergraduate Physics Conference), October 22-25; IQC represented by PhD student, Carolyn Earnest
- McGill University, November 2; IQC represented by Master's student, Guillaume Verdon-Akzam
- Atlantic Universities Physics & Astronomy Conference at Memorial University in Newfoundland, February 6; IQC represented by Master's student Thomas Alexander

Postdoctoral Fellows

In the 2015-16 fiscal, IQC overachieved its goal of recruiting five new postdoctoral fellows by successfully recruiting a total of 12. A total of 89 applications were received and reviewed throughout the year for these positions. The following postdoctoral fellows joined IQC:

Franklin Cho	Michele Piscitelli	Ibrahim Nsanzineza
Jason Crann	Dave Touchette	Geovandro Pereira
Sandra Gibson	Ben Yager	Mahmood Sabooni
Katanya Kuntz	Penghui Yao	Ying Dong

These researchers were recruited from institutions from Canada (Carleton University, McGill University) and around the world including the University of Southern California, the Royal Holloway University, the University of New South Wales and the Nation University of Singapore, further strengthening IQC's global network. A full list of current postdoctoral fellows can be found on page 65.

Profile

Electra Eleftheriadou joined IQC in April 2015, after completing her studies in Scotland: she holds a Bachelor's in Physics from Heriot-Watt University in Edinburgh (2011) and a PhD in Physics from the University of Strathclyde in Glasgow (March 2015). Her research during her PhD with Professors John Jeffers and Stephen M. Barnett focused on a protocol for amplification of coherent states of light, a process necessary for quantum communication purposes. As a postdoctoral fellow at the IQC, Electra is expanding her skills in quantum communication theory and works on the analysis of the security of quantum key distribution protocols. Electra has been an active STEM ambassador for years and embraces opportunities at the IQC to participate in outreach activities.

Graduate Students

While 132 Master's and PhD students passed through IQC in the fiscal 2015-2016, as of March 31 a total of 116 students – 37 Master's and 79 PhD – are currently enrolled. A full list of students for the fiscal year can be found on page 66.

Profile

Mike Mazurek was first introduced to the field of quantum information through a course he took during his undergraduate studies at the University of Waterloo, and he was amazed at the differences in power between quantum and classical computers. Now, as a PhD student at IQC, Mike investigates the differences between the theories of quantum and classical mechanics. As a member of Kevin Resch's Quantum Optics and Quantum Information group, Mike uses pairs of single photons to test whether or not nature behaves in ways that quantum mechanics says are possible, but classical theory says are not. It is possible that a new theory that supersedes quantum mechanics will one day be discovered, and performing these types of experimental tests lets researchers know what non-classical features need to be included in any potential "post-quantum" theory of the natural world.

Student Awards

IQC is able to attract students from around and accepts the highest quality researchers. Below is a list of awards earned by IQC graduate students this year.

Student	Award
Matthew Amy	NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral President's Graduate Scholarship
Juan Miguel Arrazola	Mike and Ophelia Lazaridis Fellowship IQC David Johnston Award for Scientific Outreach
Eduardo Barrera Ramirez	Institute for Quantum Computing Entrance Award
Kristine Boone	Institute for Quantum Computing Entrance Award President's Graduate Scholarship Ontario Graduate Scholarship
Matthew Brown	QEII-Graduate Scholarship in Science and Technology
Brandon Buonacorsi	Institute for Quantum Computing Entrance Award
Alessandro Cosentino	David R. Cheriton Graduate Scholarship
Hillary Dawkins	IQC Achievement Award President's Graduate Scholarship Ontario Graduate Scholarship NSERC Alexander Graham Bell Canada Graduate Scholarship – Masters
Olivia Di Matteo	NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral President's Graduate Scholarship
John Donohue	President's Graduate Scholarship NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral
Carolyn Earnest	IQC David Johnston Award for Scientific Outreach
Jennifer Fernick	Institute for Quantum Computing Entrance Award
Kent Fisher	President's Graduate Scholarship Ontario Graduate Scholarship

Student	Award
	NSERC Vanier Canada Graduate Scholarship
Honghao Fu	President's Graduate Scholarship Ontario Graduate Scholarship NSERC Alexander Graham Bell Canada Graduate Scholarship – Masters
Matthew Graydon	Ontario Graduate Scholarship President's Graduate Scholarship
Gregory Holloway	NSERC Postgraduate Scholarship - Doctoral President's Graduate Scholarship
Tomas Jochym-O'Connor	NSERC Vanier Canada Graduate Scholarship
Sarah Kaiser	IQC David Johnston Award for Scientific Outreach Mike and Ophelia Lazaridis Fellowship
Shitikanth Kashyap	Mike and Ophelia Lazaridis Fellowship
Sumeet Khatri	President's Graduate Scholarship Ontario Graduate Scholarship NSERC Alexander Graham Bell Canada Graduate Scholarship - Masters
Maria Kieferova	Mike and Ophelia Lazaridis Fellowship
Hyeran Kong	Institute for Quantum Computing Entrance Award
David Layden	President's Graduate Scholarship Ontario Graduate Scholarship NSERC Alexander Graham Bell Canada Graduate Scholarship - Masters
Li Liu	Mike and Ophelia Lazaridis Fellowship David R. Cheriton Graduate Scholarship
Xingliang (David) Lou	Ontario Graduate Scholarship President's Graduate Scholarship
Benjamin Lovitz	Institute for Quantum Computing Entrance Award
Jean-Philippe MacLean	NSERC Vanier Canada Graduate Scholarship
Christian Mastromattei	Ontario Graduate Scholarship President's Graduate Scholarship
Michael Mazurek	President's Graduate Scholarship Ontario Graduate Scholarship NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral
Clifford Plesha	Institute for Quantum Computing Entrance Award
Chris Pugh	NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral President's Graduate Scholarship
Daniel Puzzuoli	Ontario Graduate Scholarship President's Graduate Scholarship
Hammam Qassim	Mike and Ophelia Lazaridis Fellowship
Nayeli Azucena Rodriguez Briones	Institute for Quantum Computing Entrance Award

Student	Award
Jeff Salvail	President's Graduate Scholarship NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral
Sumit Sijher	Mike and Ophelia Lazaridis Fellowship
Dhinakaran Vinayagamurthy	Institute for Quantum Computing Entrance Award David R. Cheriton Graduate Scholarship
Sean Walker	NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral Ontario Graduate Scholarship President's Graduate Scholarship
Chunhao Wang	NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral Ontario Graduate Scholarship President's Graduate Scholarship
Kyle Willick	NSERC Alexander Graham Bell Canada Graduate Scholarship – Doctoral President's Graduate Scholarship
Joshua Young	Ontario Graduate Scholarship President's Graduate Scholarship

Alumni

This year, IQC granted degrees to seven Master's students and seven PhD students, bringing the total of IQC student alumni to 151 cumulatively. These researchers have chosen to pursue careers in various fields - from academia to industry to government – both within Ontario and around the world. The alumni profiles below highlight this diversity:

Donny Cheung, who currently works as a Senior Software Engineer in Kitchener's Google office, completed a PhD in Math with a focus on quantum algorithms in 2007. Upon graduating from IQC, Donny worked as a postdoctoral fellow at the University of Calgary, followed by a position with a medical imaging company. Since joining Google in 2012, Donny's work has mainly been focused on machine learning.

Gina Passante completed her PhD in Physics at IQC (graduated 2012) with supervisor, Raymond Laflamme, after studying quantum correlations in NMR quantum computers. Following graduation, Gina completed a three years as a postdoctoral fellow at the University of Washington in Physics Education Research where she was able to taught quantum mechanics to undergraduate physics majors. She also helped to develop research-based curriculum to improve student learning in quantum mechanics courses. Currently, Gina is an Assistant Professor at California State University, Fullerton. Her research is focused on how students learn quantum mechanics across STEM (Science, Technology, Engineering, and Mathematics) disciplines.

Continue to host timely, focused conferences, workshops, seminars and courses

Part of recruiting and retaining talent relies on building a strong and stimulating research community. As a leading institute, IQC is proud to be part of many national and international conferences, workshops and seminars held by and for researchers. This is a key priority as conferences and talks foster collaboration and promote idea exchange. This past year, IQC was host to four major conferences, three workshops, 35 seminars, 13 colloquia and jointly sponsored an additional 14 conferences held at partner organizations across the globe. Below are highlights of major conferences hosted and sponsored this year. A full list of seminars and colloquia can be found on page 81.

Major Conferences

CERC Summit, April 13-14
The University of Waterloo and IQC specifically, was host to the 5th Canada Excellence Research Chairs (CERC) annual meeting. IQC faculty member David Cory, CERC in Quantum Information Processing, co-chaired the meeting which included plenary lectures by chair holders.

NanoMRI, July 27-31
The 5th Nanoscale Magnetic Resonance Imaging (NanoMRI) Conference brought together 108 attendees from an interdisciplinary community of scientists and engineers. Hosted by IQC, this year's speakers included a select group from three communities: Magnetic Resonance Force Microscopy (MRFM), Optically-Detected Magnetic Resonance (ODMR) using nitrogen vacancy (NV) center and quantum nano mechanics.

Quantum Innovators, October 5-7
The 4th Quantum Innovators workshop brought together the most promising young researchers in quantum physics and engineering to present their research, build the community and participate in professional development activities. At this event 18 emerging researchers from across North America and Europe came to Waterloo to connect with each other and the IQC research community.

Waterloo Innovation Summit, September 16-18
The Waterloo Innovation Summit is a global conference that brings together innovators, global thought leaders, policy makers and academics who have the

power to influence change and drive prosperity. IQC was host for one day of this conference.

Workshops

Quantum Programming and Circuits Workshop, June 8-11
Organized by IQC faculty member, Michele Mosca and colleagues Martin Roetteler (Microsoft Research) and Peter Selinger (Dalhousie University), the workshop brought together researchers from quantum computing and classical programming languages. This workshop attracted approximately 65 participants.

Quantum Key Distribution Summer School, August 17-21
From August 17 to 21, IQC hosted their bi-annual summer school for undergraduate students. The Quantum Key Distribution (QKD) summer school is an international, five-day program focused on theoretical and experimental aspects of quantum communication with a focus on quantum cryptography. This year, IQC welcomed 60 (52 male and 8 female) students from around the world to participate. Of the 60 students, 24 originated from Canada with others representing China, the United States, Colombia, Israel, Pakistan, India, Mexico, South Africa, South Korea, Japan and several countries across Europe.

Teaching Quantum Technologies, Dec 5-6
Developed and lead by Martin Laforest, IQC's Senior Manager of Scientific Outreach, this workshop was held for 20 high school teachers from across Canada. The program included the development of 13 hands-on activities designed to introduce quantum mechanics and quantum technologies in a high school classroom setting.

Sponsored Workshops and Conferences

The following chart highlights the 14 national and international conferences hosted by partners and sponsored in part by IQC between April 1, 2015 and March 31, 2016.

Conference	Dates	Location
Canadian Undergraduate Technology Conference	May 1-3, 2015	Toronto
Theory Canada 10	Jun 11-14, 2015	University of Calgary
CAP Congress	Jun 15-19, 2015	University of Alberta
Bilateral Waterloo-Bristol Nanotechnology Workshop	Jun 16-19, 2015	University of Waterloo
Contextuality and Non-locality as Resources for Quantum Information	Jul 3-10, 2015	Naramata, BC
71st Scottish Universities Summer School in Physics: Frontiers in Quantum Dynamics and Quantum Optics	Jul 21-Aug 2, 2015	University of Strathclyde

Conference	Dates	Location
Women in Physics Canada	Jul 30-Aug 1, 2015	University of Toronto
Canadian Summer School on Quantum Information	Aug 10-14, 2015	Fields Institute
Quantum Marginals and Numerical Ranges Workshop	Aug 15-21, 2015	University of Guelph
5th International Conference on Quantum Cryptography (QCrypt)	Sep 28-Oct 2, 2015	Tokyo
Canadian Undergraduate Physics Conference (CUPC)	Oct 22-25, 2015	Trent University
Canadian Conference for Undergraduate Women in Physics	Jan 8-10, 2016	Dalhousie University
Quantum Information Processing	Jan 10-16, 2016	The Banff Centre
Jeux de Physique	Jan 15-17, 2016	Université de Montréal

Objective C

Brand Canada as the destination of choice for conducting research in quantum technologies and attract the best in the world to Canada, creating partnerships with the international quantum information community and promoting a world-class excellence in quantum information science and technology.

Expected Outcomes for 2015-2016

- Be a catalyst for collaborations of quantum information scientists through networks such as the Canadian Institute for Advanced Research (CIFAR) Quantum Information program, and the Natural Sciences and Engineering Research Council of Canada (NSERC) Strategic Networks
- Promote collaborations through participation in national and international conferences
- Produce internationally recognized, high-calibre publications co-authored by IQC researchers
- Organize at least four conferences that involve multidisciplinary participants
- Continue, enhance and increase visits to IQC by international scientists and academics from around the world

Highlights for 2015-2016

- Successfully continued collaborations through scientific networks like CIFAR
- Researchers participated in or attended 140 external conferences
- Welcomed 157 scientific visitors from 94 institutions from around the world

Progress Achieved for 2015-2016

Be a catalyst for collaborations of quantum information scientists through networks such as the Canadian Institute for Advanced Research (CIFAR) Quantum Information program, and the Natural Sciences and Engineering Research Council of Canada (NSERC) Strategic Networks

CIFAR

CIFAR's Quantum Information Science program is fundamentally committed to leading-edge multidisciplinary research and IQC is very well represented within this network. Currently, the program consists of 34 total members and of those, 15 or 44%, have a direct connection to IQC. Five of these members are either IQC Affiliates or Associates and 10 are IQC faculty, including Raymond Laflamme, who is the program director. Other IQC faculty members in CIFAR's Quantum Information Science program include Raffi Budakian, Andrew Childs, Richard Cleve, Joseph Emerson, Thomas Jennewein, Debbie Leung, Michele Mosca, Ashwin Nayak and John Watrous. In addition, IQC faculty member David Cory chairs the scientific advisory panel for the QIS program.

NSERC

This year three IQC faculty members were awarded grants through NSERC programs.

- Kyung Soo Choi received an NSERC Discovery grant and an equipment grant in June for his work in quantum nonlinear optics, in addition to an Early Researcher Award
- Thomas Jennewein received an NSERC Discovery award for his work on developing quantum photonics devices for quantum communications
- Michal Bajcsy received an NSERC Discovery grant for his research studying on-chip platforms for engineering photon-photon interactions and low-power quantum photonic devices

Promote collaborations through participation in national and international conferences

IQC is dedicated to finding opportunities to participate in national and international conferences. This year, faculty collectively were invited to speak at 140 other external conferences around the world. A full list of attended conferences and invited talks can be found on page 68.

Produce internationally recognized, high-calibre publications co-authored by IQC researchers

Researchers at IQC regularly collaborate with other researchers and scientists around the world in an effort to create scientific networks that produce the highest standard of research. A list of collaborative projects by researcher can be found on page 62.

Organize at least four conferences that involve multidisciplinary participants

Bringing together researchers from various backgrounds, IQC hosted several workshops and conferences to encourage young researchers, emphasize collaboration, promote idea exchange and demonstrate IQC and Canada as a leader in quantum information science research. Below are some highlights.

Undergraduate School on Experimental Quantum Information Processing (USEQIP), May 25 - June 5
IQC's annual USEQIP program attracted 198 applications from around the world. Ultimately 24 students – 9 female and 15 male - were chosen, representing countries including Canada, the United States, Brazil, Turkey, India, Bulgaria, Iran, South Korea, Germany, Denmark, Spain and the Republic of Cyprus.

Quantum Programming and Circuits Workshop, June 8-11
Organized by IQC faculty member, Michele Mosca and colleagues Martin Roetteler (Microsoft Research) and Peter Selinger (Dalhousie University), the workshop brought together researchers from quantum computing and

classical programming languages. This workshop attracted approximately 65 participants.

Quantum Cryptography School for Young Students (QCSYS), August 7-14
This year QCSYS welcomed 45 (22 female and 23 male) students from around the world to participate. Of the 45 students, 32 originated from Canada with others representing the United States, Turkey, Pakistan, the United Kingdom, Zimbabwe, South Africa, Brazil and the United Arab Emirates.

Quantum Key Distribution Summer School, August 17-21
From August 17 to 21, IQC hosted their bi-annual summer school for undergraduate students. The Quantum Key Distribution (QKD) summer school is an international, five-day program focused on theoretical and experimental aspects of quantum communication with a focus on quantum cryptography. This year, IQC welcomed 60 (52 male and 8 female) students from around the world to participate. Of the 60 students, 24 originated from Canada with others representing China, the United States, Colombia, Israel, Pakistan, India, Mexico, South Africa, South Korea, Japan and several counties across Europe.

Quantum Innovators, October 5-7
The 4th Quantum Innovators workshop brought together the most promising young researchers in quantum physics and engineering to present their research, build the community and participate in professional development activities. At this event 18 emerging researchers from across North America and Europe came to Waterloo to connect with each other and the IQC research community.

Continue, enhance and increase visits to IQC by international scientists and academics from around the world

Every year IQC is proud to welcome scientific visitors from across the globe. Their time at IQC serves to further and enhance collaborative relationships with researchers in all fields. This year, IQC welcomed 157 scientific visitors. These visitors collectively represent 94 research institutions or universities from 21 international countries and five Canadian provinces. A full list of scientific visitors can be found in on page 83.

Tours

In addition to scientific visitors, IQC hosts many other tours for leaders of government, industry and academia. A full list of all group tours lead by IQC can be found in on page 88.

Objective D

Enhance and expand the Institute's public education and outreach activities to effectively promote science and quantum information science and demonstrate how the research from quantum information science can be applied for the purpose of sustaining and attracting world-class talent.

Expected Outcomes for 2015-2016

- Host two major undergraduate and high school summer schools
- Host three Quantum Frontiers Distinguished Lectures
- Establish and plan for a major open house event in 2015
- Establish relationships with key strategic partners to further share IQC's research discoveries
- Establish a new teacher/student outreach program
- Continue to share IQC's research through publications, web and social media outlets

Highlights for 2015-206

- Hosted two major summer schools – USEQIP and QCSYS
- Hosted three Quantum Frontiers Distinguished Lectures
- Hosted a major open house event for over 700 attendees
- Partnered on an exhibition on light attracting over 40,000 attendees
- Won awards for communications and grew online presence

Progress Achieved in 2015-2016

Host two major undergraduate and high school summer schools

From May 25 to June 5, IQC hosted its annual undergraduate summer school, USEQIP – **Undergraduate School on Experimental Quantum Information Processing**. The program attracted 198 applications from around the world. Ultimately, students – 9 female and 15 male - were chosen, representing countries including Canada, the United States, Brazil, Turkey, India, Bulgaria, Iran, South Korea, Germany, Denmark, Spain and the Republic of Cyprus. The program featured talks and hands-on experiments lead

QCSYS participants explore quantum levitation using superconductivity.

by several IQC faculty and researchers including Martin Laforest, David Cory, Michele Mosca, Kevin Resch, Michal Bajcsy, Matteo Mariantoni and John Watrous.

The **Quantum Cryptography School for Young Students** (QCSYS) was held August 7-14. This year, IQC welcomed 45 (22 female and 23 male) students from around the world to participate. Of the 45 students, 32 originated from Canada with others representing the United States, Turkey, Pakistan, the United Kingdom, Zimbabwe, South Africa, Brazil and the United Arab Emirates.

Host three Quantum Frontiers Distinguished Lectures

In 2015, IQC proudly hosted three globally recognized researchers for the Quantum Frontiers Distinguished Lecture series.

Dr. Sajeev John, University of Toronto, April 30
Lecture: *Photonic band gap materials: semiconductors of light*
Attendees: 65

Leo Kouwenhoven, Delft University of Technology, May 28
Lecture: *Majorana Fermions: Particle Physics on a Chip*
Attendees: 50

Immanuel Bloch, Max Planck Institute of Quantum Optics, June 24
Lecture: *From Topological Bloch Bands to Long-Range Interacting Rydberg Gases - New Frontiers for Ultracold Atoms*
Attendees: 85

Establish and plan for a major open house event in 2015

Raymond Laflamme giving a talk at IQC's Open House.

On October 3, 2015, as part of the University of Waterloo's campus-wide alumni reunion event, IQC hosted an Open House at the Mike and Ophelia Lazaridis Quantum-Nano Centre. The all-day event, which was advertised through social media and local schools, was free to all members of the public. Attendance for the day reached a total of 740 people. Below are the highlights of activities presented:

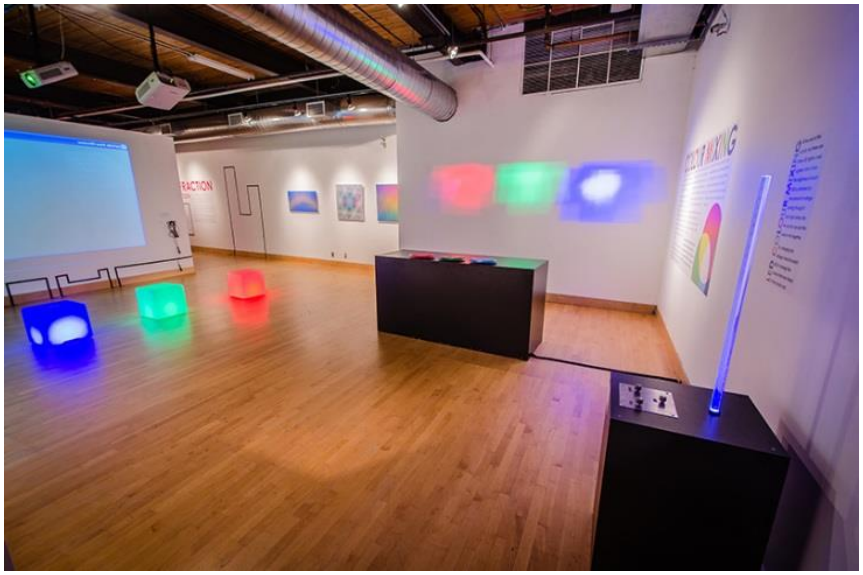
- A public talk by IQC's Executive Director, Raymond Laflamme (moderated by local radio spokesperson, Mike Farwell) on the future of quantum technologies for 233 attendees.
- Kids Science Show – presented by IQC PhD student Chris Pugh and postdoctoral fellow Electra Eleftheriadou (140 in attendance)

- ‘Ask a Scientist’ area where IQC students volunteered to take questions from the public in a one-on-one format
- The Games Institute Interactives Experiences – IQC collaborated with the University of Waterloo’s Games Institute to create interactive experiences that would allow the public to engage with quantum science in unique and meaningful ways. These projects were showcased at the Open House and include:
  - Quantum Cats – an interactive game application where users gain introductory knowledge of quantum concepts
  - Virtual Lab Tour – a touch-enabled virtual tour of an IQC quantum optics lab
  - Self-guided, technology-enabled tour – a tour whereby users travelled through the Mike & Ophelia Lazaridis Quantum-Nano Centre with their smartphone to learn about the buildings and the research that happens here

Establish relationships with key strategic partners to further share IQC’s research discoveries

International Year of Light

Six University of Waterloo graduate students, including five from within IQC, lead the creation and development of an interactive temporary exhibition at THEMUSEUM in Waterloo Region. This exhibition was installed collaboratively with THEMUSEUM and opened to the public in mid-October. Spanning 5,000 square feet, the exhibition comprised of 17 interactive modules that explain the scientific properties of light and the benefits of light-based technology in celebration of the United Nations declaring 2015 the International Year of Light. While on display, 40,083 members of the public, including school groups and youth, visited THEMUSEUM.



Installation of Light Illuminated at THEMUSEUM.

QUANTUM: The Exhibition

This year, IQC's Communications and Strategic Initiatives team embarked on a project to create a unique outreach vehicle to engage Canadians in quantum research in an innovative and meaningful way.

IQC is developing a 4,000 square foot travelling exhibition featuring interactive, entertaining and educational exhibits sharing the wonders of the quantum world. The exhibition will communicate how current research in quantum information science is revolutionizing technology.

In the summer of 2015, IQC applied for a grant through the Department of Canadian Heritage, Canada 150 Fund and was awarded a signature initiative grant of $1 million towards the $2.1 million project.

IQC researchers – faculty, postdoctoral fellows and students – have engaged in the planning and content development to ensure that the exhibition is scientifically accurate and engages a variety of audiences.

As of March 31, the status of the project remains embedded in developing content and design with plans to move into fabrication in April of 2016.

The exhibition is scheduled to launch at THEMUSEUM in downtown Kitchener in the fall of 2016, followed by a cross-Canada tour at large science centres.

INNOVATION150

Upon receiving funding for the quantum exhibition project, via the Department of Canadian Heritage, IQC established a partnership with four other Canadian scientific organizations to work collaboratively with on sesquicentennial celebrations. The partners, now jointly referred to as INNOVATION150, include Perimeter Institute for Theoretical Physics, Actua, Canada's Science and Technology Museums Corporation and the Canadian Association of Science Centres. With the travelling quantum exhibition as IQC's main contribution, INNOVATION150 will work to develop and tour, science-based programs and events to share with Canadians in 2017.

The Games Institute at the University of Waterloo

A strong collaborative relationship was established this year with the University of Waterloo's Games Institute. As part of the collaboration, the Games Institute was tasked with the creation and development of three interactive experiences to engage members of the public with quantum-related content. A virtual tour of a quantum optics lab, a self-guided digital tour through IQC's building and a quantum-themed game application (Quantum Cats) all launched on October 3 at IQC's Open House event.

A child plays Quantum Cats at IQC's Open House

Establish a new teacher/student outreach program

The pilot program for Teaching Quantum Technologies (TQT) took place at IQC on December 5 – 6. Developed and lead by Martin Laforest, IQC's Senior Manager of Scientific Outreach, this workshop was held for 20 high school teachers from across Canada – over 60 teachers applied. The program included the development of 13 hands-on activities designed to introduce quantum mechanics and quantum technologies in a high school classroom setting. Participants left the workshop with an increased ability to teach quantum mechanics beyond the basics and to discuss with students how quantum mechanics can transform society. TQT is serving as a launching point for IQC's expansion of teacher networks across Canada.

Continue to share IQC's research through publications, web and social media outlets

The communications team at IQC ensures that the researchers and their work are recognized worldwide through publications, media releases and online platforms.

Publications

NewBit, IQC's newsletter, highlights recent research results and includes feature articles and stories on outreach initiatives, conferences, events and other announcements. NewBit is published each term and distributed to IQC faculty, students, staff, board members and academic, government and industry partners. Approximately 2,000 copies are printed and distributed. It is also made available online in both an accessible PDF format and Flipbook format for download.

IQC's news writing and NewBit publication were recognized for excellence in communication through the following awards:

- Canadian Council for the Advancement of Education (CCAE) Prix d'Excellence Gold 2015 – NewBit (Best Brochure, Flyer or Newsletter)
- Council for the Advancement and Support of Education (CASE) District II
  - Gold – NewBit (External Audience Newsletters) 2015
  - Bronze – Sharing quantum with the world: IQC Research & Science News
- Writing *(Excellence in News Writing)* 2016
- Awards for Publication Excellence (APEX) 2015 – NewBit *(Newsletters – Writing)*

Earned Media

The return on the efforts of IQC's communications strategy extends far and wide. With local, national and international attention on varying activities within IQC, thousands of impressions were garnered this fiscal. A full list of earned media can be found on page 90 and the chart below outlines the highlights from this year.

Date	Media Outlet	Reference/Specific	Media Tier
04-24-2015	CBC	Reference – Mike Lazaridis, IQC	National
04-29-2015	Wall Street Journal	Reference – Raymond Laflamme, IQC	National
05-06-2015	Nanotechnology Now	Specific – IQC, Quantum NanoFab, Vito Logiudice	International Science
05-11-2015	The Globe & Mail	Reference – Research2Reality, quantum physics, Canadian research	National

Date	Media Outlet	Reference/Specific	Media Tier
05-19-2015	CBC	Specific – King and Queen of the Netherlands to visit Waterloo Region May 28	National
05-25-2015	The Waterloo Region Record	Specific – Visit from Dutch royalty	Regional
05-25-2015	National Post	Specific – Visit from Dutch royalty	National
05-26-2015	The Globe and Mail	Specific – Education partnership, Dutch visit to Canada	National
05-26-2015	CBC	Specific – Dutch royals kick off Canadian visit with YYT stop	National
05-28-2015	CTV News	Specific – Waterloo hosts royals	Regional/national
06-02-2015	CPA Magazine	Specific – Quantum Valley	National
06-04-2105	The Waterloo Region Record	Specific – Quantum partnership for cybersecurity, evolutionQ, Terepac	Regional
06-26-2015	Maclean's	Reference – IQC	National
06-28-2015	Stratford Beacon Herald	Specific – Raymond Laflamme at the Stratford Festival, public lecture	Regional
06-30-2015	The Globe and Mail	Reference – IQC	National
09-02-2015	New Scientist	Reference – Chris Wilson	International Science
09-08-2015	Nature	Reference – Michele Mosca, IQC	International Science
09-08-2015	The Globe and Mail	Reference – Mike Lazaridis, Quantum Valley, IQC, quantum computing	National
09-08-2015	The Waterloo Region Record	Reference – Mike Lazaridis, Quantum Valley, IQC, quantum computing	Regional
09-08-2015	Scientific American	Reference – Michele Mosca, IQC	International Science
09-09-2015	CTV Kitchener	Reference – IQC	Regional
09-24-2015	The Globe & Mail	Specific – Paul Corkum, former board member	National
10-07-2015	Maclean's	Reference – Quantum Cats game	National
10-22-2015	The Globe & Mail	Reference – David Fransen, IQC	National
11-01-2015	The Waterloo Region Record	Specific – John Fish, QCSYS student	Regional
11-02-2015	CBC	Specific – John Fish, QCSYS student	National
11-12-2015	Science Daily	Specific - NIST, University of Waterloo, Krister Shalm	International Science
11-17-2015	The Globe & Mail	Specific – IQC, Thomas Jennewein, David Cory	National
11-22-2015	The Toronto Star	Reference – David Cory, Waterloo	Regional

Date	Media Outlet	Reference/Specific	Media Tier
11-24-2015	The Waterloo Region Record - Tech Spotlight	Specific – IQC, quantum computing, Michele Mosca, Thomas Jennewein	Regional
11-25-2015	Maclean's	Reference – IQC, Raymond Laflamme	National
12-01-2015	Canadian Business	Reference – IQC, Raymond Laflamme	National
02-08-2016	Science and Technology Research News	Reference – IQC, Raymond Laflamme	International Science
02-09-2016	CBC	Reference – IQC, Raymond Laflamme	National
02-20-2016	Nanotechnology Now	Specific – Experimental nonlocal and surreal Bohmian trajectories	International Science
02-22-2016	International Business Times	Specific – Experimental nonlocal and surreal Bohmian trajectories	International Science
03-15-2016	Metro	Specific – Canada 150/Innovation150 announcement	Regional

Social Media

With a presence on major social media platforms, IQC is able to stay connected with current stakeholders, media, alumni and the general public, to share in the moment news related to IQC and what's happening in the quantum field generally. This year, all three platforms employed by IQC – YouTube, Facebook and Twitter – grew in subscribers. Following are the highlights for each network's performance between April 1, 2015 and March 31, 2016.

	New Followers	Total Current Followers	Reach	Engagement
YouTube	2,611	7,573	241,902 views	2,409,393 minutes watched
Facebook	510	3,522	175,276	9,416
Twitter	1,487	5,870	1,509,357 impressions	36,936 / 1,807 retweets

Our Quantum World

May of this year also saw the launch of a dedicated IQC blog – Our Quantum World. This blog is curated on a volunteer basis by a committee that includes IQC faculty, students and staff. Each post is written by quantum researchers for quantum researchers and those interested in their work. Topics vary every two weeks from an introduction to quantum mechanics to comparisons of research findings, from summaries of recent conferences to an introduction to new areas of research. We are encouraging guest bloggers, alumni and IQC members to provide posts. At March 31, the most recent blog post had 617 page views, as compared to 133 page views of the first post, indicating significant growth in popularity.

Objective E

Position Canada to take advantage of economic and social benefits of research through seizing opportunities to commercialize breakthrough research.

Expected Outcomes for 2015-2016

- Host commercialization workshops for IQC researchers
- Host industry workshop for industry partners to showcase opportunities in quantum technologies

Progress Achieved in 2015-2016

In the last year, four patent applications were submitted by IQC researchers David Cory, Joseph Emerson, Guo-Xing Miao and Michele Mosca. This will bring IQC's total number of patents to 41.

As of March 2016, there have been a total of five spinoff companies to come out of IQC: Universal Quantum Devices (UQD), evolutionQ, Quspin, High Q Technologies, and Neutron Optics.

In 2015-2016, IQC began development of an Industry Affiliate Program to help bridge researchers with industry. This development is in early stages. To date, IQC has identified 82 Canadian companies and laboratories currently developing quantum devices or having the potential to incorporate quantum devices in their future products. Together, they form the basis of Canada's emerging quantum information industry. IQC will host an industry workshop by fall of 2016 to help inform the new quantum industry affiliate program and to plan the quantum technology transfer calendar for 2016 – 2017.

Note: *The University of Waterloo's Intellectual Property policy (Policy #73) states that intellectual property is owned by the discoverer. Researchers are not required to report on patents or commercialization activities. With this in mind, the number of patents and or licences may actually be higher.*

APPENDICES

A. Risk Assessment & Mitigation Strategies

		LIKELIHOOD		
		LOW	MED	HIGH
IMPACT	HIGH	6	8	9
	MED	3	5	7
	LOW	1	2	4

Risk Factor	Impact Score	Likelihood Score	Risk Rating	Explanation of Score	Mitigation Measures
IQC may not be able to attract high quality researchers	High	Medium	8	The market for world-class researchers is increasingly competitive with many countries making significant investments.	Pursue recruits from a wide breadth of areas of research. Offer competitive job offers/ package. Adequately promote the world-class researchers and the cutting-edge facilities/ equipment at IQC. Further invest in cutting edge laboratory facilities.
Transformational technologies may render current research less relevant	High	Low	6	If IQC research is rendered less relevant, HQP and data seekers will go elsewhere	Ensure a wide breadth of research to investigate (this would differentiate IQC from its competitors). Continue applications for research funds to support leading-edge equipment.
IQC may not be able to recruit enough HQPs	High	Low	6	Many international HQPs come from potentially politically unstable countries (top three are Iran, China, India)	Promote IQC sufficiently. Ensure excellent research. Diversify markets/ countries from which students are recruited.
Operating constraints limit IQC's efforts to brand itself	High	Low	6	Operating constraints include limited resources (including staff), degree of flexibility	Recruit the right people/talents/skills. Develop and deliver a branding project plan. Foster close working relationships with appropriate units within the university.

B. Financial Information

Institute for Quantum Computing - ISED Spending
for the period April 1, 2015 - March 31, 2016

Research, HQP Development	$	3,814,546
Pre-Commercialization	$	133,489
Outreach and Communications	$	631,066
Management, Admin & Support	$	752,915
Total	**$**	**5,332,016**

NOTE: An audited Statement of Contributions and Expenses will follow.

C. Publications

April 1 - December 31, 2015

Arunachalam, S., Gheorghiu, V., Jochym-O'Connor, T., Mosca, M., & Srinivasan, P. V. (2015). On the robustness of bucket brigade quantum RAM. New J. Phys., 17, 16 pp.

Arunachalam, S., Johnston, N., & Russo, V. (2015). Is Absolute Separability Determined By The Partial Transpose? Quantum Inform. Comput., 15(7-8), 694–720.

Bal, M., Ansari, M. H., Orgiazzi, J. - L., Lutchyn, R. M., & Lupascu, A. (2015). Dynamics of parametric fluctuations induced by quasiparticle tunneling in superconducting flux qubits. Physical Review B, 91(19).

Bandyopadhyay, S., Cosentino, A., Johnston, N., Russo, V., Watrous, J., & Yu, N. (2015). Limitations on Separable Measurements by Convex Optimization. Ieee Transactions On Information Theory, 61(6), 3593–3604.

Blasco, A., Garay, L. J., Martin-Benito, M., & Martin-Martinez, E. (2015). Violation of the Strong Huygen's Principle and Timelike Signals from the Early Universe. Physical Review Letters, 114(14).

Boone, K., Bourgoin, J. - P., Meyer-Scott, E., Heshami, K., Jennewein, T., & Simon, C. (2015). Entanglement over global distances via quantum repeaters with satellite links. Physical Review A, 91(5).

Bourgoin, J. P., Gigov, N., Higgins, B. L., Yan, Z. Z., Meyer-Scott, E., Khandani, A. K., et al. (2015). Experimental quantum key distribution with simulated ground-to-satellite photon losses and processing limitations. Phys. Rev. A, 92(5), 12 pp.

Bourgoin, J. P., Higgins, B. L., Gigov, N., Holloway, C., Pugh, C. J., Kaiser, S., et al. (2015). Free-space quantum key distribution to a moving receiver. Opt. Express, 23(26), 33437–33447.

Brandao, F. G. S. L., Piani, M., & Horodecki, P. (2015). Generic emergence of classical features in quantum Darwinism. Nat. Commun., 6, 8 pp.

Bravyi, S., & Gosset, D. (2015). Gapped and gapless phases of frustration-free spin-1/2 chains. Journal Of Mathematical Physics, 56(6).

Carignan-Dugas, A., Wallman, J. J., & Emerson, J. (2015). Characterizing universal gate sets via dihedral benchmarking. Phys. Rev. A, 92(6), 5 pp.

Chen, J. X., Ji, Z. F., Li, C. K., Poon, Y. T., Shen, Y., Yu, N. K., et al. (2015). Discontinuity of maximum entropy inference and quantum phase transitions. New J. Phys., 17, 18 pp.

Chen, L., & Dokovic, D. Z. (2015). Boundary of the set of separable states. Proc. R. Soc. A-Math. Phys. Eng. Sci., 471(2181), 22 pp.

Chen, L., & Dokovic, D. Z. (2015). Dimension formula for induced maximal faces of separable states and genuine entanglement. Quantum Inf. Process., 14(9), 3335–3350.

Cheng, G. - L., Zhong, W. - X., & Chen, A. - X. (2015). Phonon induced phase grating in quantum dot system. Optics Express, 23(8), 9870–9880.

Cheng, G. L., Chen, A. X., & Zhong, W. X. (2015). Greenberger-Horne-Zeilinger Entanglement of Six Separated Resonators via Concurrent Parametric Down-Conversion. Int. J. Theor. Phys., 54(8), 2467–2480.

Cheng, G. L., Wang, Y. P., & Chen, A. X. (2015). Phase-controlled coherent population trapping in superconducting quantum circuits. Chin. Phys. B, 24(4), 6 pp.

Childs, A. M., Gosset, D., Nagaj, D., Raha, M., & Webb, Z. (2015). Momentum Switches. Quantum Inform. Comput., 15(7-8), 601–621.

Christensen, B. G., Hill, A., Kwiat, P. G., Knill, E., Nam, S. W., Coakley, K., et al. (2015). Analysis of coincidence-time loopholes in experimental Bell tests. Phys. Rev. A, 92(3), 13 pp.

Clark, C. W., Barankov, R., Huber, M. G., Arif, M., Cory, D. G., & Pushin, D. A. (2015). Controlling neutron orbital angular momentum. Nature, 525(7570), 504–+.

Combes, J., & Ferrie, C. (2015). Cost of postselection in decision theory. Phys. Rev. A, 92(2), 9 pp.

Cui, S. X., Yu, N. K., & Zeng, B. (2015). Generalized graph states based on Hadamard matrices. J. Math. Phys., 56(7), 17 pp.

Dawkins, H., & Howard, M. (2015). Qutrit Magic State Distillation Tight in Some Directions. Physical Review Letters, 115(3).

Deng, C. Q., Orgiazzi, J. L., Shen, F., Ashhab, S., & Lupascu, A. (2015). Observation of Floquet States in a Strongly Driven Artificial Atom. Phys. Rev. Lett., 115(13), 5 pp.

Dokovic, D. Z., & Kotsireas, I. S. (2015). Some new periodic Golay pairs. Numerical Algorithms, 69(3), 523–530.

Dokovic, D. Z., Kotsireas, I., Recoskie, D., & Sawada, J. (2015). Charm bracelets and their application to the construction of periodic Golay pairs. Discrete Applied Mathematics, 188, 32–40.

Donohue, J. M., & Wolfe, E. (2015). Identifying nonconvexity in the sets of limited-dimension quantum correlations. Phys. Rev. A, 92(6), 11 pp.

Espoukeh, P., Rahimi, R., Salimi, S., & Pedram, P. (2015). Dynamics of entanglement and non-classical correlation for four-qubit GHZ state. Int. J. Quantum Inf., 13(6), 14 pp.

Ferrie, C., & Moussa, O. (2015). Robust and efficient in situ quantum control. Physical Review A, 91(5).

Fillion-Gourdeau, F., & MacLean, S. (2015). Time-dependent pair creation and the Schwinger mechanism in graphene. Physical Review B, 92(3), 5401.

Forest, S., Gosset, D., Kliuchnikov, V., & McKinnon, D. (2015). Exact synthesis of single-qubit unitaries over Clifford-cyclotomic gate sets. J. Math. Phys., 56(8), 26 pp.

Geraedts, S., Zaletel, M. P., Papic, Z., & Mong, R. S. K. (2015). Competing Abelian and non-Abelian topological orders in nu=1/3+1/3 quantum Hall bilayers. Phys. Rev. B, 91(20), 16 pp.

Gharavi, K., & Baugh, J. (2015). Orbital Josephson interference in a nanowire proximity-effect junction. Phys. Rev. B, 91(24), 14 pp.

Gosset, D., Terhal, B. M., & Vershynina, A. (2015). Universal Adiabatic Quantum Computation via the Space-Time Circuit-to-Hamiltonian Construction. Physical Review Letters, 114(14).

Grassl, M., Shor, P. W., Smith, G., Smolin, J., & Zeng, B. (2015). New Constructions of Codes for Asymmetric Channels via Concatenation. IEEE TRANSACTIONS ON INFORMATION THEORY, 61(4), 1879–1886.

Gunthner, T., Pressl, B., Laiho, K., Gessler, J., Hofling, S., Kamp, M., et al. (2015). Broadband indistinguishability from bright parametric downconversion in a semiconductor waveguide. Journal Of Optics, 17(12).

Hallgren, S., Smith, A., & Song, F. (2015). Classical cryptographic protocols in a quantum world. International Journal Of Quantum Information, 13(4), 50028.

Herdman, C. M., & Del Maestro, A. (2015). Particle partition entanglement of bosonic Luttinger liquids. Physical Review B, 91(18).

Hincks, I. N., Granade, C. E., Borneman, T. W., & Cory, D. G. (2015). Controlling Quantum Devices with Nonlinear Hardware. Phys. Rev. Appl., 4(2), 8 pp.

Hoi, I. C., Kockum, A. F., Tornberg, L., Pourkabirian, A., Johansson, G., Delsing, P., et al. (2015). Probing the quantum vacuum with an artificial atom in front of a mirror. Nat. Phys., 11(12), 1045–1049.

Howard, M. (2015). Classical codes in quantum state space. J. Phys. A-Math. Theor., 48(49), 14 pp.

Howard, M. (2015). Maximum nonlocality and minimum uncertainty using magic states. Physical Review A, 91(4).

Huang, Z. W., Chen, A. X., Zhang, Z., & Yang, W. X. (2015). Generation of ultrashort extreme-ultraviolet pulses by enhanced plasmonic near-fields in metallic nanoparticles. Epl, 111(2), 6 pp.

Jin, J., Puigibert, M. G., Giner, L., Slater, J. A., Lamont, M. R. E., Verma, V. B., et al. (2015). Entanglement swapping with quantum-memory-compatible photons. Phys. Rev. A, 92(1), 6 pp.

Jin, J., Saglamyurek, E., Puigibert, M. L., Verma, V., Marsili, F., Nam, S. W., et al. (2015). Telecom-Wavelength Atomic Quantum Memory in Optical Fiber for Heralded Polarization Qubits. Phys. Rev. Lett., 115(14), 5 pp.

Kermarrec, E., Maharaj, D. D., Gaudet, J., Fritsch, K., Pomaranski, D., Kycia, J. B., et al. (2015). Gapped and gapless short-range-ordered magnetic states with (1/2,1/2,1/2) wave vectors in the pyrochlore magnet Tb2+xTi2-xO7+delta. Phys. Rev. B, 92(24), 7 pp.

Kim, I. H., & Brown, B. J. (2015). Ground-state entanglement constrains low-energy excitations. Phys. Rev. B, 92(11), 11 pp.

Klassen, J., & Wen, X. G. (2015). Topological degeneracy (Majorana zero-mode) and 1+1D fermionic topological order in a magnetic chain on superconductor via spontaneous Z(2)(f) symmetry breaking. J. Phys.-Condes. Matter, 27(40), 5 pp.

Kulchytskyy, B., Herdman, C. M., Inglis, S., & Melko, R. G. (2015). Detecting Goldstone modes with entanglement entropy. Phys. Rev. B, 92(11), 11 pp.

Laarhoven, T., Mosca, M., & van de Pol, J. (2015). Finding shortest lattice vectors faster using quantum search. Designs Codes Cryptogr., 77(2-3), 375–400.

Lee, C. H., Papic, Z., & Thomale, R. (2015). Geometric Construction of Quantum Hall Clustering Hamiltonians. Phys. Rev. X, 5(4), 24 pp.

Lee, S. K., Cho, J., & Choi, K. S. (2015). Emergence of stationary many-body entanglement in driven-dissipative Rydberg lattice gases. New J. Phys., 17, 19 pp.

Lee, S. Y., Thompson, J., Raeisi, S., Kurzynski, P., & Kaszlikowski, D. (2015). Quantum information approach to Bose-Einstein condensation of composite bosons. New J. Phys., 17, 12 pp.

Leung, D., & Matthews, W. (2015). On the Power of PPT-Preserving and Non-Signalling Codes. IEEE Trans. Inf. Theory, 61(8), 4486–4499.

Li, X. - H., & Ghose, S. (2015). Hyperentanglement concentration for time-bin and polarization hyperentangled photons. Physical Review A, 91(6).

Li, X. H., & Ghose, S. (2015). Optimal joint remote state preparation of equatorial states. Quantum Inf. Process., 14(12), 4585–4592.

Locht, I. L. M., Di Marco, I., Garnerone, S., Delin, A., & Battiato, M. (2015). Ultrafast magnetization dynamics: Microscopic electronic configurations and ultrafast spectroscopy. Phys. Rev. B, 92(6), 15 pp.

Lu, D., Li, H., Trottier, D. - A., Li, J., Brodutch, A., Krismanich, A. P., et al. (2015). Experimental Estimation of Average Fidelity of a Clifford Gate on a 7-Qubit Quantum Processor. Physical Review Letters, 114(14).

Martin-Martinez, E. (2015). Causality issues of particle detector models in QFT and quantum optics. Phys. Rev. D, 92(10), 18 pp.

Martin-Martinez, E., & Louko, J. (2015). (1+1)D Calculation Provides Evidence that Quantum Entanglement Survives a Firewall. Phys. Rev. Lett., 115(3), 5 pp.

Miatto, F. M., Piche, K., Brougham, T., & Boyd, R. W. (2015). Recovering full coherence in a qubit by measuring half of its environment. Phys. Rev. A, 92(6), 5 pp.

Mohammadzadeh, H., Ebadi, Z., Mehri-Dehnavi, H., Mirza, B., & Darabad, R. R. (2015). Entanglement of arbitrary spin modes in expanding universe. Quantum Inf. Process., 14(12), 4787–4801.

Muller, M. P., Adlam, E., Masanes, L., & Wiebe, N. (2015). Thermalization and Canonical Typicality in Translation-Invariant Quantum Lattice Systems. Commun. Math. Phys., 340(2), 499–561.

Namiki, R. (2015). Amplification uncertainty relation for probabilistic amplifiers. Phys. Rev. A, 92(3), 11 pp.

Namiki, R., & Azuma, K. (2015). Quantum Benchmark via an Uncertainty Product of Canonical Variables. Phys. Rev. Lett., 114(14), 6 pp.

Ni, Y., Xu, P., & Martin, J. D. D. (2015). Reduction of the dc-electric-field sensitivity of circular Rydberg states using nonresonant dressing fields. Phys. Rev. A, 92(6), 10 pp.

Ong, F. R., Cui, Z., Yurtalan, M. A., Vojvodin, C., Papaj, M., Orgiazzi, J. L. F. X., et al. (2015). Suspended graphene devices with local gate control on an insulating substrate. Nanotechnology, 26(40), 9 pp.

Owerre, S. A., & Nsofini, J. (2015). A toy model for quantum spin Hall effect. Solid State Communications, 218, 35–39.

Owerre, S. A., & Nsofini, J. (2015). Antiferromagnetic molecular nanomagnets with odd-numbered coupled spins. Epl, 110(4), 47002.

Park, D. K., Feng, G., Rahimi, R., Labruyere, S., Shibata, T., Nakazawa, S., et al. (2015). Hyperfine spin qubits in irradiated malonic acid: heat-bath algorithmic cooling. Quantum Information Processing, 14(7), 2435–2461.

Pashayan, H., Wallman, J. J., & Bartlett, S. D. (2015). Estimating Outcome Probabilities of Quantum Circuits Using Quasiprobabilities. Phys. Rev. Lett., 115(7), 5 pp.

Piani, M. (2015). Channel steering. J. Opt. Soc. Am. B-Opt. Phys., 32(4), A1–A7.

Ponte, P., Chandran, A., Papic, Z., & Abanin, D. A. (2015). Periodically driven ergodic and many-body localized quantum systems. Annals Of Physics, 353, 196–204.

Ponte, P., Papic, Z., Huveneers, F., & Abanin, D. A. (2015). Many-Body Localization in Periodically Driven Systems. Physical Review Letters, 114(14).

Potocek, V., Miatto, F. M., Mirhosseini, M., Magana-Loaiza, O. S., Liapis, A. C., Oi, D. K. L., et al. (2015). Quantum Hilbert Hotel. Phys. Rev. Lett., 115(16), 5 pp.

Pozas-Kerstjens, A., & Martin-Martinez, E. (2015). Harvesting correlations from the quantum vacuum. Phys. Rev. D, 92(6), 18 pp.

Raeisi, S., Kurzynski, P., & Kaszlikowski, D. (2015). Entropic Tests of Multipartite Nonlocality and State-Independent Contextuality. Physical Review Letters, 114(20).

Ried, K., Agnew, M., Vermeyden, L., Janzing, D., Spekkens, R. W., & Resch, K. J. (2015). A quantum advantage for inferring causal structure. Nature Physics, 11(5), 415–421.

Roy, T., Kundu, S., Chand, M., Vadiraj, A. M., Ranadive, A., Nehra, N., et al. (2015). Broadband parametric amplification with impedance engineering: Beyond the gain-bandwidth product. Appl. Phys. Lett., 107(26), 5 pp.

Sajeed, S., Chaiwongkhot, P., Bourgoin, J. - P., Jennewein, T., Luetkenhaus, N., & Makarov, V. (2015). Security loophole in free-space quantum key distribution due to spatial-mode detector-efficiency mismatch. Physical Review A, 91(6).

Salton, G., Mann, R. B., & Menicucci, N. C. (2015). Acceleration-assisted entanglement harvesting and rangefinding. New Journal Of Physics, 17.

Shalm, L. K., Meyer-Scott, E., Christensen, B. G., Bierhorst, P., Wayne, M. A., Stevens, M. J., et al. (2015). Strong Loophole-Free Test of Local Realism. Phys. Rev. Lett., 115(25), 10 pp.

Sheldon, S., & Cory, D. G. (2015). Demonstration of open-quantum-system optimal control in dynamic nuclear polarization. Phys. Rev. A, 92(4), 11 pp.

Simoen, M., Chang, C. W. S., Krantz, P., Bylander, J., Wustmann, W., Shumeiko, V., et al. (2015). Characterization of a multimode coplanar waveguide parametric amplifier. J. Appl. Phys., 118(15), 9 pp.

Sinha, A., Vijay, A. H., & Sinha, U. (2015). On the superposition principle in interference experiments. Scientific Reports, 5.

Soh, D. B. S., Brif, C., Coles, P. J., Lutkenhaus, N., Camacho, R. M., Urayama, J., et al. (2015). Self-Referenced Continuous-Variable Quantum Key Distribution Protocol. Phys. Rev. X, 5(4), 15 pp.

Versteegh, M. A. M., Reimer, M. E., van den Berg, A. A., Juska, G., Dimastrodonato, V., Gocalinska, A., et al. (2015). Single pairs of time-bin-entangled photons. Phys. Rev. A, 92(3), 8 pp.

Gheorghiu V, M. C. de O. and B. C. S. (2015). Nonzero Classical Discord. Phys. Rev. Lett., 115.

Wallman, J., Granade, C., Harper, R., & Flammia, S. T. (2015). Estimating the coherence of noise. New J. Phys., 17, 13 pp.

Wallman, J. J., Barnhill, M., & Emerson, J. (2015). Robust Characterization of Loss Rates. Phys. Rev. Lett., 115(6), 5 pp.

Wu, Q. P., Liu, Z. F., Chen, A. X., & Xiao, X. B. (2015). Fermi velocity modulation of spin-dependent transport in graphene. J. Phys. D-Appl. Phys., 48(35), 6 pp.

Xu, F. H., Arrazola, J. M., Wei, K. J., Wang, W. Y., Palacios-Avila, P., Feng, C., et al. (2015). Experimental quantum fingerprinting with weak coherent pulses. Nat. Commun., 6, 9 pp.

Yang, H., Zhang, F., Green, S. R., & Lehner, L. (2015). Coupled oscillator model for nonlinear gravitational perturbations. Physical Review D, 91(8).

Yang, H., Zhang, F., & Lehner, L. (2015). Magnetosphere of a Kerr black hole immersed in magnetized plasma and its perturbative mode structure. Phys. Rev. D, 91(12), 14 pp.

Yang, W. - X., Chen, A. - X., Huang, Z., & Lee, R. - K. (2015). Ultrafast optical switching in quantum dot-metallic nanoparticle hybrid systems. Optics Express, 23(10), 13032–13040.

Yu, N., & Ying, M. (2015). Optimal simulation of Deutsch gates and the Fredkin gate. Physical Review A, 91(3).

Zeng, B., & Wen, X. - G. (2015). Gapped quantum liquids and topological order, stochastic local transformations and emergence of unitarity. PHYSICAL REVIEW B, 91(12).

Zhao, Y. -yuan, Yu, N. -kun, Kurzynski, P., Xiang, G. -yong, Li, C. - F., & Guo, G. - C. (2015). Experimental realization of generalized qubit measurements based on quantum walks. Physical Review A, 91(4).

Zhu, Z., Yang, W. - X., Chen, A. - X., Liu, S., & Lee, R. - K. (2015). Two-dimensional atom localization via phase-sensitive absorption-gain spectra in five-level hyper inverted-Y atomic systems. Journal Of The Optical Society Of America B-Optical Physics, 32(6), 1070–1077.

Ashenfelter, J., Balantekin, B., Baldenegro, C. X., Band, H. R., Barclay, G., Bass, C. D., et al. (2016). Background radiation measurements at high power research reactors. Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip., 806, 401–419.

Bajcsy, M., & Majumdar, A. (2016). QUANTUM OPTICS Arithmetic with photons. Nat. Photonics, 10(1), 4–6.

Berta, M., Christandl, M., & Touchette, D. (2016). Smooth Entropy Bounds on One-Shot Quantum State Redistribution. IEEE Trans. Inf. Theory, 62(3), 1425–1439.

Beverland, M. E., Buerschaper, O., Koenig, R., Pastawski, F., Preskill, J., & Sijher, S. (2016). Protected gates for topological quantum field theories. J. Math. Phys., 57(2), 39 pp.

Bhupathi, P., Groszkowski, P., DeFeo, M. P., Ware, M., Wilhelm, F. K., & Plourde, B. L. T. (2016). Transient Dynamics of a Superconducting Nonlinear Oscillator. Phys. Rev. Appl., 5(2), 14 pp.

Blasco, A., Garay, L. J., Martin-Benito, M., & Martin-Martinez, E. (2016). Timelike information broadcasting in cosmology. Phys. Rev. D, 93(2), 17 pp.

Brodutch, A., & Cohen, E. (2016). Nonlocal Measurements via Quantum Erasure. Phys. Rev. Lett., 116(7), 6 pp.

Chen, J. Y., Ji, Z. F., Liu, Z. X., Shen, Y., & Zeng, B. (2016). Geometry of reduced density matrices for symmetry-protected topological phases. Phys. Rev. A, 93(1), 7 pp.

Chen, J. X., Ji, Z. F., Yu, N. K., & Zeng, B. (2016). Detecting consistency of overlapping quantum marginals by separability. Phys. Rev. A, 93(3), 6 pp.

Childs, A. M., & Young, J. (2016). Optimal state discrimination and unstructured search in nonlinear quantum mechanics. Phys. Rev. A, 93(2), 7 pp.

Corona-Ugalde, P., Martin-Martinez, E., Wilson, C. M., & Mann, R. B. (2016). Dynamical Casimir effect in circuit QED for nonuniform trajectories. Phys. Rev. A, 93(1), 9 pp.

Crann, J., Kribs, D. W., Levene, R. H., & Todorov, I. G. (2016). Private algebras in quantum information and infinite-dimensional complementarity. J. Math. Phys., 57(1), 14 pp.

Dosseva, A., Cincio, L., & Branczyk, A. M. (2016). Shaping the joint spectrum of down-converted photons through optimized custom poling. Phys. Rev. A, 93(1), 7 pp.

Graydon, M. A., & Appleby, D. M. (2016). Quantum conical designs. J. Phys. A-Math. Theor., 49(8), 20 pp.

Hiai, F., & Ruskai, M. B. (2016). Contraction coefficients for noisy quantum channels. J. Math. Phys., 57(1), 33 pp.

Hummer, D., Martin-Martinez, E., & Kempf, A. (2016). Renormalized Unruh-DeWitt particle detector models for boson and fermion fields. Phys. Rev. D, 93(2), 50 pp.

Jochym-O'Connor, T., & Bartlett, S. D. (2016). Stacked codes: Universal fault-tolerant quantum computation in a two-dimensional layout. Phys. Rev. A, 93(2), 12 pp.

Kawahigashi, Y., Garcia, D. P., & Ruskai, M. B. (2016). Introduction to Special Issue: Operator Algebras and Quantum Information Theory. J. Math. Phys., 57(1), 1 pp.

Levick, J., Jochym-O'Connor, T., Kribs, D. W., Laflamme, R., & Pereira, R. (2016). Private quantum subsystems and quasiorthogonal operator algebras. Journal Of Physics A-Mathematical And Theoretical, 49(12).

Li, K., Arif, M., Cory, D. G., Haun, R., Heacock, B., Huber, M. G., et al. (2016). Neutron limit on the strongly-coupled chameleon field. Phys. Rev. D, 93(6), 9 pp.

Li, X. H., & Ghose, S. (2016). Self-assisted complete maximally hyperentangled state analysis via the cross-Kerr nonlinearity. Phys. Rev. A, 93(2), 8 pp.

Lloyd, S., Garnerone, S., & Zanardi, P. (2016). Quantum algorithms for topological and geometric analysis of data. Nat. Commun., 7, 7 pp.

Kliuchnikov, V., Maslov, D., & Mosca, M. (2016). Practical Approximation of Single-Qubit Unitaries by Single-Qubit Quantum Clifford and T Circuits. IEEE Trans. Comput., 65(1), 161–172.

Martin-Martinez, E., Smith, A. R. H., & Terno, D. R. (2016). Spacetime structure and vacuum entanglement. Phys. Rev. D, 93(4), 13 pp.

Meyer-Scott, E., McCloskey, D., Golos, K., Salvail, J. Z., Fisher, K. A. G., Hamel, D. R., et al. (2016). Certifying the Presence of a Photonic Qubit by Splitting It in Two. Phys. Rev. Lett., 116(7), 6 pp.

Muralidharan, S., Li, L. S., Kim, J., Lutkenhaus, N., Lukin, M. D., & Jiang, L. (2016). Optimal architectures for long distance quantum communication. Sci Rep, 6, 10 pp.

Nayak, A., Sikora, J., & Tuncel, L. (2016). A search for quantum coin-flipping protocols using optimization techniques. Math. Program., 156(1-2), 581–613.

Saravani, M., Aslanbeigi, S., & Kempf, A. (2016). Spacetime curvature in terms of scalar field propagators. Phys. Rev. D, 93(4), 13 pp.

Shahi, C. B., Arif, M., Cory, D. G., Mineeva, T., Nsofini, J., Sarenac, D., et al. (2016). A new polarized neutron interferometry facility at the NCNR. Nucl. Instrum. Methods Phys. Res. Sect. A-Accel. Spectrom. Dect. Assoc. Equip., 813, 111–122.

Verdon-Akzam, G., Martin-Martinez, E., & Kempf, A. (2016). Asymptotically limitless quantum energy teleportation via qudit probes. Phys. Rev. A, 93(2), 13 pp.

Wood, C. J., & Cory, D. G. (2016). Cavity cooling to the ground state of an ensemble quantum system. Phys. Rev. A, 93(2), 9 pp.

Yang, H., & Zhang, F. (2016). Plasma-Wave Generation In A Dynamic Spacetime. Astrophys. J., 817(2), 6 pp.

Yang, Y. H., Li, L., Liu, F., Gao, Z. W., & Miao, G. X. (2016). Enhancing spin injection efficiency through half-metallic miniband conduction in a spin-filter superlattice. J. Phys.-Condes. Matter, 28(5), 12 pp.

D. Faculty Members and Research Assistant Professors

Faculty Members

1. Michal Bajscy
2. Jonathan Baugh
3. Raffi Budakian
4. Andrew Childs
5. Kyung Soo Choi
6. Richard Cleve
7. David Cory
8. Joseph Emerson
9. Thomas Jennewein
10. Na Young Kim
11. Raymond Laflamme
12. Debbie Leung
13. Adrian Lupascu
14. Norbert Lütkenhaus
15. Matteo Mariantoni
16. Guo-Xing Miao
17. Michele Mosca
18. Ashwin Nayak
19. Vern Paulsen
20. Michael Reimer
21. Kevin Resch
22. Adam Wei Tsen
23. John Watrous
24. Christopher Wilson

Research Assistant Professors

1. Vadim Makarov
2. Eduardo Martin-Martinez
3. Dmitry Pushin
4. William Slofstra

E. Collaborations

Faculty Member	Collaborative Research Networks
Raffi Budakian	University of Illinois, USA
David Cory	Perimeter Institute for Theoretical Physics, Canada Goodyear Schlumberger-Doll Research Laboratory, USA Infinite Potential Group, Canada Brockhouse Institute, McMaster University, Canada Shanghai Center for Complex Physics, China Quantum Valley Investments, Canada High Q, Canada
Richard Cleve	Computational Complexity, Switzerland
Joseph Emerson	Canadian Institute for Advanced Research (CIFAR), Canada Perimeter Institute for Theoretical Physics, Canada University of Guelph, Canada University of Innsbruck, Austria University of Sydney, Australia
Thomas Jennewein	Perimeter Institute for Theoretical Physics, Canada University of Innsbruck, Austria University of Calgary, Canada National Institute of Standards and Technology (NIST), USA University of Seville, Spain Politecnico di Milano, Italy Nicolaus Copernicus University in Torun, Poland University of Vienna, Austria University of Waterloo, Canada University of Toronto & UTIAS Space Flight Laboratory, Canada McGill University, Canada Canadian Space Agency, Canada COMDEV Inc., Canada National Institute of Optics (INO), Canada Excelitas (former Perkin Elmer), Canada DotFAST C2C Link Corporation, Canada Princeton Lightwave, USA Xiphos, Canada Neptec, Canada
Raymond Laflamme	Canadian Institute for Advanced Research (CIFAR), Canada Department of Defence, Canada

Faculty Member	Collaborative Research Networks
	Communication Security Establishment, Canada Universal Quantum Devices, Canada Canadian Space Agency, Canada Perimeter Institute for Theoretical Physics, Canada Quantum Investment Funds, Canada Infinite Potential Inc., Canada COM DEV Inc, Canada Technion – Israel Institute for Technology, Israel Quantum Symphony (Indianapolis), USA Quantum Symphony (Ottawa), Canada
Debbie Leung	Perimeter Institute for Theoretical Physics, Canada Canadian Institute for Advanced Research (CIFAR), Canada Cambridge University, UK University of Maryland, USA
Norbert Lütkenhaus	Computational Complexity, Springer Basel AG, Germany
Vadim Makarov	Federal University of Ceará, Brazil Universidad de Valladolid, Spain University of Toronto, Canada Northwestern University, USA Korea Institute of Science and Technology, South Korea University of Illinois, USA State Pedagogical University, Russia École Polytechnique de Montréal, Canada ID Quantique SA, Switzerland University of Vigo, Spain University of Valladolid, Spain National University of Defense and Technology, China Massachusetts Institute of Technology, USA Moscow State University, Russia
Eduardo Martin-Martinez	Universidad Complutense de Madrid, Spain
Guo-Xing Miao	Hefei National Laboratory for Physical Sciences at the Microscale, China Francis Bitter Magnet Laboratory, Massachusetts Institute of Technology, USA Department of Physics, University of Toronto, Canada Qingdao University, China
Michele Mosca	Natural Sciences and Engineering Research Council of Canada (NSERC) CREATE European Telecommunications Standards Institute (ETSI), France

Faculty Member	Collaborative Research Networks
	Institute for Quantum Science and Technology (IQST), University of Calgary, Canada
	Université de Montréal, Canada
	Tech Capital Partners, Canada
	McGill University, Canada
	COM DEV Inc, Canada
	Perimeter institute for Theoretical Physics, Canada
	National Institute of Standards and Technology (NIST), Canada
	Swiss Federal institute of Technology in Zurich (ETHZ), Switzerland
	ID Quantique, Switzerland
	Institute for Security, Privacy and Information Assurance, University of Calgary, Canada
	Centre for Quantum Technologies (CQT), National University of Singapore, Singapore
	Security Innovations, USA
	Tutte Institute for Mathematics and Computing, Canada
	Ontario Centres of Excellence, Canada
	MITACS, Canada
	Trustpoint, Canada
	SERENE, Canada
	Approach Infinity Inc., Canada
	University of Ottawa, Canada
	Government of Canada, Canada
	InfoSec Global, Canada
	SignitSure Inc., USA
Vern Paulsen	Texas A & M University, USA
Dmitry Pushin	National Institute of Standards and Technology, USA
	University of Maryland, USA
Michael Reimer	Eindhoven University of Technology, The Netherlands
	National Research Council of Canada, Canada
	Royal Institute of Technology, Sweden
	Delft University of Technology, The Netherlands
	Stanford University, USA
Kevin Resch	National Research Council (NRC), Canada
	Perimeter Institute for Theoretical Physics, Canada

F. Postdoctoral Fellows

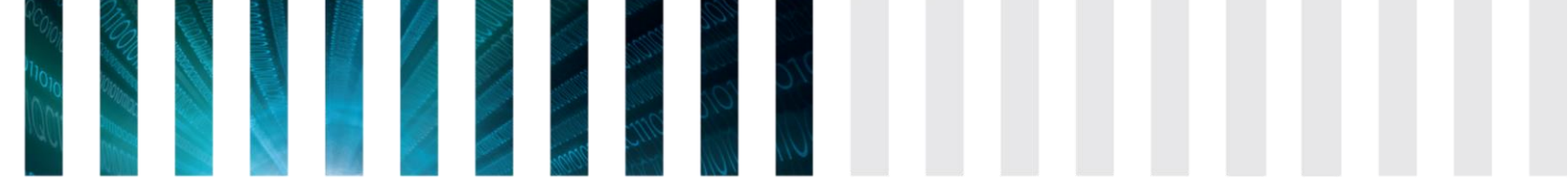
Current postdoctoral fellows at IQC.

Troy Borneman
Jean-Philippe Bourgoin
Aharon Brodutch
Franklin Cho
Patrick Coles
Joshua Combes
Jason Crann
Electra Eleftheriadou
Guanru Feng
Pol Forn-Diaz
Ying Dong
Vlad Gheorghiu
Sandra Gibson
Christopher Haapamaki
Christopher Herdman
Brendon Higgins
Jeongwan Jin
Milad Khoshnegar
Katanya Kuntz
Sangil Kwon
Chang Liu
Ying Liu
Dawei Lu
Filippo Miatto
Taisiya Mineeva
Ryo Namiki
George Nichols
Ibrahim Nsanzineza
Geovandro Pereira
Michele Piscitelli
Mahmood Sabooni
Fang Song
Rainer Stohr
Dave Touchette
Joel Wallman
Ben Yager
Huan Yang
Penghui Yao
Taehyun Yoon
Nengkun Yu
Hui Zhang
Yanbao Zhang

G. Graduate Students

The following are graduate students part of the IQC community from April 1, 2015 to March 31, 2016.

Sascha Agne
Arash Ahmadi
Shahab Akmal
Rubayet Al Maruf
Thomas Alexander
Omar Alshehri
Matthew Amy
Vadiraj Ananthapadmanabha Rao
Elena Anisimova
Razieh Annabestani
Juan Miguel Arrazola
Golam Bappi
Marie Barnhill
Ryan Barrage
Eduardo Barrera Ramirez
Jeremy Bejanin
Marian Berek
Kristine Boone
Mitchell Brickson
Matthew Brown
Brandon Buonacorsi
Arnaud Carignan-Dugas
Poompong Chaiwongkhot
Christopher Chamberland
Chung Wai Sandbo Chang
Jiahui Chen
Paulina Corona Ugalde
Alessandro Cosentino
Hillary Dawkins
Chunqing Deng
Rahul Deshpande
Olivia Di Matteo
John Donohue
Carolyn Earnest
Jennifer Fernick
Kent Fisher
Jeremy Flannery
Honghao Fu
Zhiwei Gao
Naimeh Ghafarian
Kaveh Gharavi
Nicolas Gonzalez
Matthew Graydon
Daniel Grimmer
Peter Groszkowski
Aimee Gunther
Holger Haas
Guiyang Han
Ian Hincks
Gregory Holloway
Darryl Hoving
Anqi Huang
Vinay Iyer
David Jepson
Yuantao Ji
Tomas Jochym-O'Connor
Sarah Kaiser
Shitikanth Kashyap
Hemant Katiyar
Sumeet Khatri
Maria Kieferova
Feyruz Kitapli
Hyeran Kong
Anirudh Krishna
Meenu Kumari
David Layden
Han Le
Lin Li
Madelaine Liddy
Piers Lillystone
Jie Lin
Li Liu
Kevin Liu
Xudong Liu
Ray Liu
Guofei Long
Xingliang (David) Lou
Benjamin Lovitz
David Luong
Xian Ma



Jean-Philippe MacLean
Christian Mastromattei
Michael Mazurek
Thomas McConkey
Corey Rae McRae
Evan Meyer-Scott
Maryam Mirkamali
Mohamad Niknam
Joachim Nsofini
Jean-Luc Orgiazzi
Martin Otto
Satish Pandey
Alex Parent
Kyungdoeck Park
Jihyun Park
Helen Percival
Clifford Plesha
Jitendra Prakash
Chris Pugh
Daniel Puzzuoli
Hammam Qassim
John Rinehart
Nayeli Azucena Rodriguez Briones
Romain Ruhlmann
Dolly Natalia Ruiz Amador
Vincent Russo
Allison Sachs
Shihan Sajeed
Jeff Salvail
Yuval Sanders
Dusan Sarenac
John Schanck
Behrooz Semnani
Ala Shayeghi
Feiruo Shen
Sumit Sijher
Nigar Sultana
Yongchao Tang
Alexander Valtchev
Guillaume Verdon-Akzam
Dhinakaran Vinayagamurthy
Sean Walker
Zimeng Wang
Chunhao Wang
Christopher Warren
Zak Webb
Kyle Willick
Christopher Wood
Yihang Yang
Joshua Young
Muhammet Yurtalan
Mohd Zeeshan

H. Invited Talks and Conference Participation

Faculty	Date	Title/Subject	Institution/ Conference	Location
Michal Bajcsy	Jun-15	Integrated platforms for quantum and nonlinear optics with single photons	University of Bristol	Bristol, UK
	Jun-15	Integrated platforms for quantum and nonlinear optics with single photons	Waterloo Institute of Nanotechnology, University of Waterloo	Waterloo, ON, Canada
Jonathan Baugh	Jul-15	From Subband Structure to Single Electron Devices in Semiconductor Nanowires (talk given by my student Greg Holloway)	PIERS International conference	Prague, Czech Republic
	Jul-15	Orbital Interference Effects in Nanowire Josephson Junctions for Exploring Majorana Physics	Canadian Association of Physicists Congress	Edmonton, AB, Canada
Kyung Soo Choi	May-15	Building synthetic quantum systems with atoms and photons – From waveguide QED with neutral atoms to many-body physics with Rydberg-dressed lattice gases	State University of New York at Stony Brook	Stony Brook, NJ, USA
	Jun-15	Building synthetic quantum systems with atoms and photons – From waveguide QED with neutral atoms to many-body physics with Rydberg-dressed lattice gases	Korean Academy of Science and Tech	Seoul, Korea
	Jul-15	Building synthetic quantum systems with atoms and photons – From waveguide QED with neutral atoms to many-body physics with Rydberg-dressed lattice gases	NanoKorea 2015	Seoul, Korea

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Sep-15	Building synthetic quantum systems with atoms and photons – From waveguide QED with neutral atoms to many-body physics with Rydberg-dressed lattice gases	Korea Institute for Advanced Study (KIAS)	Seoul, Korea
	Jan-16	Building synthetic quantum systems with atoms and photons – From waveguide QED with neutral atoms to many-body physics with Rydberg-dressed lattice gases	Korea Institute for Advanced Study (KIAS)	Seoul, Korea
	Feb-16	Building synthetic quantum systems with atoms and photons – From waveguide QED with neutral atoms to many-body physics with Rydberg-dressed lattice gases	State Key Laboratory of Precision Spectroscopy, ECNU	Shanghai, China
Richard Cleve	Jul-15	Satellite Workshop of ICALP/LICS 2015, Workshop on Computational Complexity	Kyoto University	Kyoto, Japan
	Dec-15	Workshop on Quantum Random Walks and Quantum Algorithms	Lorentz Center	Leiden, The Netherlands
David Cory	May-15	Quantum Devices	Defense Research and Development Canada	Ottawa, ON, Canada
	Apr-15	The Impact of Quantum Devices	National Institute of Standards and Technology	Gaithersburg, MD, USA
	Apr-15	The Impact of Quantum Devices	Canada Excellence Research Chairs (CERC)	Waterloo, ON, Canada
	May-15	Engineering Quantum Devices	Guelph-Waterloo Centre for Graduate Studies in Chemistry	Guelph, ON, Canada

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Nov-15	Tools for Scaling Up	IBM	New York, NY, USA
	Nov-15	Royal Society of Canada Annual General Meeting 2015	Royal Society of Canada	Victoria, BC, Canada
	Nov-15	CIFAR-China Quantum Information Program Meeting	The Canadian Institute for Advanced Research (CIFAR) and Tsinghua University	Beijing, China
Joseph Emerson	Feb-16	Noise Tailoring for Universal Quantum Computation via Randomized Compiling	University of Sydney	Sydney, NSW, Australia
	Nov-15	Noise Tailoring for Universal Quantum Computation via Randomized Compiling	The Canadian Institute for Advanced Research (CIFAR)	Beijing, China
	Aug-15	Resources for Quantum Computation	University of Toronto	Toronto, ON, Canada
	Jun-15	Which Resources Power Quantum Computation?	Last Frontiers of Quantum Information workshop	Homer, Alaska, USA
	Oct-15	Quantum Information Technology and the Future of the Internet	Internet2	Cleveland, OH, USA
	Jun-15	CIFAR Quantum Information Science Program Meeting	The Canadian Institute for Advanced Research (CIFAR)	Charlottetown, PEI, Canada
Thomas Jennewein	Nov-15	Entangled photon triplets and heralding single photons	Computational Science and Research Centre	Beijing, China
	Nov-15	Satellite based bridges for a global quantum internet	NASA	Langley, VA, USA
	Oct-15	Satellite based bridges for a global quantum internet	York University	Toronto, ON, Canada
	Oct-15	Satellite Quantum Communications	ETSI	Seoul, South Korea
	Oct-15	Testing quantum correlations of three entangled photons from	Conference on Lasers and Electro-Optics (CLEO)	Munich, Germany

Faculty	Date	Title/Subject	Institution/ Conference	Location
		cascaded parametric down conversion		
	May-15	Entangled Photon Triplets	Quantum Physics of Nature (QUPON) Conference	Vienna, Austria
	May-15	Towards a global quantum internet	University of Toronto	Toronto, ON, Canada.
	Apr-15	Tools for a quantum internet	Fredonia University	Fredonia, NY, USA
	Jun-15		The UK-Canada Frontiers of Science	Whistler, BC, Canada
	Nov-15	Entangled photon triplets and heralding single photons	Nanjing University	Nanjing, China
Raymond Laflamme	Jan-15	Colloquia: Experimental Quantum Error Correction	Indiana University	Bloomington, IN, USA
	Nov-15	Experimental Quantum Error Correction	Beijing Computational Science Research Center	Beijing, China
	Nov-15	Algorithmic Cooling	The Canadian Institute for Advanced Research (CIFAR) and Tsinghua University	Beijing, China
	Oct-15	Colloquia: Experimental Quantum Error Correction	Yale University	New Haven, CT, USA
	Aug-15	Experimental Quantum Error Correction	Perimeter Institute for Theoretical Physics	Waterloo, ON, Canada
	Mar-15	Quantum Information Science	University of Victoria	Lansdowne, BC, Canada
	Nov-15	Co-organizer, IQC-CIFAR-Tsinghua meeting	The Canadian Institute for Advanced Research (CIFAR) and Tsinghua meeting	Beijing, China
Debbie Leung	Nov-15	Maximum privacy without coherence, zero-error	Grup d'Informació Quàntica (Quantum Information Group)	Barcelona, Spain

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Nov-15	Entanglement can increase asymptotic rates of zero-error classical communication over classical channels	Grup d'Informació Quàntica (Quantum Information Group)	Barcelona, Spain
	Sep-15	On the power of PPT-preserving and non-signalling codes	University of Maryland	College Park, MD, USA
	Jul-15	Near-linear constructions of exact unitary 2-designs	Banff International Research Station (BIRS)	Banff, AB, Canada
	Apr-15	Near-linear constructions of exact unitary 2-designs	California Institute of Technology (Caltech)	Pasadena, CA, USA
	Apr-15	Near-linear constructions of exact unitary 2-designs	IBM TJ Watson Research Center	Yorktown Heights, NY, USA
	Nov-15	On the power of PPT-preserving and non-signalling codes	Tutte Colloquium, University of Waterloo	Waterloo, ON, Canada
Adrian Lupascu	Nov-15	Observation of Floquet states in a strongly driven artificial atom	Beijing Computational Science Research Centre	Beijing, China
	Jul-15	Observation of Floquet states in a strongly driven artificial atom	Nanjing University and The University of Hong Kong	Nanjing, China
Norbert Lütkenhaus	May-15	Quantum Repeaters and Networks	Asilomar Conference Grounds	Pacific Grove, CA, USA
	Jul-15	Trustworthy Quantum Information	Lurie Engineering Center	Ann Arbor, MI, USA
	Jul-15	Security and Cryptography	Max Planck Symposium	Munich, Germany
	Jul-15	Scalable Information Processing with Quantum Nano-Photonics	Raytheon BBN Technologies	Cambridge, MA, USA
	May-15	Qrepeaters Conference	Asilomar Conference Grounds	Pacific Grove, CA, USA
	Jun-15	Crossing Conference 2015	Technische Universitat Darmstadt	Darmstadt, Germany

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Jun-15	Hub's event launch	Ron Cooke Hub University of York	Heslington, UK
	Jun-15	Inaugural EAB Meeting	Grange Hotel	York, UK
	Jul-15	Trustworthy Quantum Information Workshop		Ann Arbor, MI, USA
	Sep-15	SECANT Meeting		Livermore, CA, USA
	Sep-15	NFV and QKD: A Necessary Convergence	University of Bristol	Bristol, UK
Vadim Makarov	Aug-15	SPIE Optics + Photonics		San Diego, CA, USA
	Sep-15	Norwegian cryptographic seminar		Trondheim, Norway
	Jun-15	FRISC workshop on information security		Reykjavik, Iceland
	Jul-15	Progress and challenges in quantum cryptography	Telecom ParisTech	Paris, France
	Oct-15	Progress in quantum cryptography and its practical security	POSTECH	Pohang, South Korea
	Oct-15	Progress in quantum cryptography and its practical security	NSR	Daejeon, South Korea
	Oct-15	Progress in quantum cryptography and its practical security	Korea Institute for Advanced Study (KIAS)	Suwon, South Korea
	Oct-15	Progress in quantum cryptography and its practical security	Chongqing University	Chongqing, China
	Oct-15	Limits on physical security of quantum communications	National University of Defense Technology	Changsha, China
	Oct-15	Limits on physical security of quantum communications	University of Science and Technology China (USTC)	Hefei, China
	Nov-15	Limits on physical security of quantum communications	University of Science and Technology China (USTC)	Hefei, China

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Dec-15	The ultimate attack on quantum communications	École Polytechnique de Montreal	Montreal, QC, Canada
	Oct-15	Measurements of light emission from silicon avalanche photodetectors (poster)	Hitotsubashi University	Tokyo, Japan
	Oct-15	Spatial-mode detector efficiency mismatch security loophole in free-space QKD (talk)	Hitotsubashi University	Tokyo, Japan
	Oct-15	Gap between industrial and academic solutions to implementation loopholes: testing random-gate-removal countermeasure in commercial QKD system (poster)	Hitotsubashi University	Tokyo, Japan
	Oct-15	Demonstration of suitability of avalanche photodiodes for quantum communications in the low-Earth-orbit radiation environment (poster)	Hitotsubashi University	Tokyo, Japan
	Oct-15	Low-noise single-photon detector for long-distance free-space quantum communication (poster)	Hitotsubashi University	Tokyo, Japan
	Jul-15	Testing the suitability of avalanche photodiodes for quantum communications in the low-Earth-orbit radiation environment (talk)	University of Geneva	Geneva, Switzerland
	Jul-15	Low-noise single-photon detector for long-distance free-space quantum communication (poster)	University of Geneva	Geneva, Switzerland

Faculty	Date	Title/Subject	Institution/ Conference	Location
Eduardo Martin-Martinez	Sep-15	International workshop on Strings, Blackholes and Quantum Information	Tokyo University	Tokyo, Japan
	Jul-15	Northern Hemisphere International Workshop on Relativistic Quantum Information	University of Dartmouth	Hanover, NH, USA
Guo-Xing Miao	Dec-15	Quantum life abroad	East China Jiaotong University	Nanchang, China
	Mar-16	Application of Magnetic semiconductors on spintronic devices	2016 EMN Meetings	Keauhou Bay, HI, USA
	Mar-16	Proximity enhanced superconductor superlattices for resonators	Chinese Academy of Science	Beijing, China
	Nov-15	CIFAR-China Quantum Information Processing	Tsinghua University	Beijing, China
Michele Mosca	Mar-16	Panelist: The Quantum Computing Threat to Encryption	2016 International Cyber Risk Management Conference	Toronto, ON, Canada
	Feb-16	Quantum Algorithms	International Association for Cryptologic Research (IACR)	Fukuoka, Japan
	Sep-15	Quantum and Security	The Conference Board of Canada-Council of Chief Information Officers	Toronto, ON, Canada
	Sep-15	Quantum and Security	The Conference Board of Canada-Council of Information Technologies Executives	Toronto, ON, Canada
	Aug-15	Keynote: Cybersecurity in a quantum world, will we be ready?	Quantum Cryptography Summer School for Young Scientists (QCSYS), IQC	Waterloo, ON, Canada
	Jul-15	Towards quantum safe cryptography	Internet Research Task Force (IRTF)	Toronto, ON, Canada

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Jul-15	Cybersecurity in a quantum world, will Canada be ready?	Public Safety Canada	Ottawa, ON, Canada
	Jul-15	Cybersecurity in a quantum world: will we be ready?	Max Planck Symposium on Foundation of Cyber Security and Privacy	Munich, Germany
	Jun-15	Panelist: Risk vs Benefits of Emerging Technologies	Hello Tomorrow Tech Conference technologies	Paris, France
	Jun-15	Cybersecurity in a quantum world: will we be ready?	Google Canada	Kitchener, ON, Canada
	May-15	Cybersecurity in a quantum world, will Canada be ready?	Public Safety Canada	Ottawa, ON, Canada
	Apr-15	Cybersecurity in a quantum world, will Canada be ready?	Communications Security Establishment	Ottawa, ON, Canada
	Apr-15	Cybersecurity in a quantum world: will we be ready?	SERENE RISC	Ottawa, ON, Canada
	Apr-15	Plenary: Cybersecurity in a quantum world, will we be ready?	National Institute of Standards and Technology (NIST)	Gaithersburg, MD, USA
	Oct-15	Co-organizer of the third ETSI workshop on quantum-safe cryptography	SK Telecom	Seoul, Korea
	Sep-15	Co-organizer, Dagstuhl seminar on "Quantum Cryptanalysis	Leibniz-Zentrum für Informatik	Frankfurt, Germany
	Jun-15	Co-organizer of the Quantum Programming Languages and Circuit Workshop	Institute for Quantum Computing (IQC)	Waterloo, ON, Canada
Ashwin Nayak	Feb-16	Quantum Information Seminar "Sampling Quantum States"	Institut de Recherche en Informatique Fondamentale (IRIF), University of Paris	Paris, France

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Sep-15	Quantum Information Seminar "A simple proof of the quantum data processing inequality"	Laboratoire d'Informatique Algorithmique : Fondements et Applications (LIAFA), University of Paris	Paris, France
	Feb-16	Quantum Information Seminar "Sampling Quantum States"	Combinatorics and Optimization, University of Waterloo	Waterloo, ON, Canada
	Aug-15	15th Canadian Summer School on Quantum Information	N/A	Toronto, ON, Canada
Dmitry Pushin	Oct-15	Twisting Neutron Waves	11th International Symposium on Characterization of Metals and Nanostructured Materials by Neutron and X-ray Synchrotron Scattering	Daejeon, South Korea
	Feb-16	The Quantum Neutron	University of Maryland	College Park, MD, USA
	Mar-16	Twisting Neutron Waves	APS March meeting	Baltimore, MD, USA
Michael Reimer	Dec-15	Strongly entangled photon sources in position controlled nanowires	University of Linz	Linz, Austria
	Oct-15	Strongly entangled photon source in position controlled nanowires	Technion – Israel Institute of Technology	Jerusalem, Israel
	Apr-15	Quantum Optics with Nanowires	Materials Research Society	San Francisco, CA, USA
	Apr-15	New nanoscale source of on-demand entangled photon pairs	Stanford	San Francisco, CA, USA
Kevin Resch	Jun-15	Entangled photon triplets: a new quantum light source and a test of nonlocality	Canadian Association of Physicists (CAP)	Edmonton, AB, Canada

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Jun-15	Quantum experiments with entangled photon triplets	Photonics North	Ottawa, ON, Canada
	Jun-15	UB-WIN workshop on nanotechnology Presented by Grad Student J. Donohue	UB-WIN workshop on nanotechnology, University of Waterloo	Waterloo, ON, Canada
	Jun-15	An experimental test of noncontextuality without unwarranted idealizations. Presented by Grad Student M. Mazurek	UB-WIN workshop on nanotechnology	Waterloo, ON, Canada
	May-15	Storage and retrieval of THz-bandwidth single photons using a room-temperature diamond quantum memory Presented by Grad Student K. Fisher	CLEO 2015	San Jose, CA, USA
	May-15	Ultrafast time-to-frequency demultiplexing of polarization-entanged photons. Presented by Grad Student J. Donohue	CLEO 2015	San Jose, CA, USA
	May-15	An idealization-free experimental test of noncontextuality Presented by Grad Student M. Mazurek	Perimeter Institute for Theoretical Physics	Waterloo, ON, Canada
William Slofstra	Mar-16	Commuting operator strategies for linear constraint system games	University of Ottawa	Ottawa, ON, Canada
	Jan-16	Staircase diagrams and smooth Schubert varieties	University of Western Ontario	London, ON, Canada
	Nov-15	Schubert varieties and inversion hyperplane arrangements	University of Western Ontario	London, ON, Canada
	Oct-15	Schubert varieties and the combinatorics of hyperplane arrangements	University of Waterloo	Waterloo, ON, Canada

Faculty	Date	Title/Subject	Institution/ Conference	Location
	Oct-15	Billey-Postnikov decompositions and enumeration of smooth Schubert varieties	University of Waterloo	Waterloo, ON, Canada
	Sep-15	Billey-Postnikov decompositions and a compactification of contangent bundles of cominuscule Grass-mannians	University of Toronto	Toronto, ON, Canada
	Apr-15	Schubert varieties and the combinatorics of hyperplane arrangements	University of Washington	Seattle, WA, USA
	Jan-16	Quantum Information Processing	Banff Centre	Banff, AB, Canada
	Jan-16	Commutative Algebra meets Algebraic Combinatorics	University of Western Ontario	London, ON, Canada
Wei Tsen	Mar-16	Weaking Bound and Strong Interacting: 1T-TaS2 and NbSe2 in the 2D Limit	American Physical Society (APS)	Baltimore, MA, USA
John Watrous	Jan-16	Quantum Interactive Proofs and Semidefinite Programs	QIP 2016 Tutorial Session	Calgary, AB, Canada
	Aug-15	Elements of Quantum Information	Canadian Summer School on Quantum Information	Toronto, ON, Canada
	Aug-15	Semidefinite Programming, Cone Programming, and Quantum State Discrimination	Workshop on Quantum Marginals and Numerical Ranges	Guelph, ON, Canada
Christopher Wilson	2015	Quantum electrodynamics in 1D using a superconducting artificial atom	Duke University	Durham, NC, USA
	2015	Quantum electrodynamics in 1D using a superconducting artificial atom	Harvard University	Cambridge, MA, USA
	2015	Quantum electrodynamics in 1D	Northwestern University	Evanston, IL, USA

Faculty	Date	Title/Subject	Institution/ Conference	Location
		using a superconducting artificial atom		
	2015	Observation of the Dynamical Casimir Effect in a Superconducting Circuit	Yale University	New Haven, CT, USA
	2015	Observation of the Dynamical Casimir Effect in a Superconducting Circuit	Dartmouth College	Hanover, NH, USA

I. Seminars and Colloquia

Seminars

	Speaker	Topic
Apr-10	Ben Baragiola	Quantum networks: driving a quantum system with propagatig Fock states of light
Apr-30	Matthieu Nannini	Nanolithography using Thermal Probe AFM: principle and applications
May-01	Tim J. Bartley	Mesoscopic quantum optics
May-20	Michele Piscitelli	Ultralow Field MRI and Beyond: Exploring current applications of SQUID-detected NMR
May-21	Urbasi Sinha	Surprises regarding the Superposition principle in interference experiments
May-26	Scott Aaronson	Exploring the Limits of the Efficiently Computable
Jun-09	Erik Woodhead	
Jun-10	Aleksander Kubica	Unfolding the color code
Jun-23	Matthew McKague	Interactive proofs for BQP via self-test graph states
Jun-30	Dong Yang	Operational resource theory of coherence
Jul-14	Fabian Furrer	Continuous-Variable Protocols in the Noisy-Quantum-Storage Model
Jul-30	Christoph Simon	Extending the quantum domain with quantum optics
Aug-05	Britton Plourde	Superconducting Metamaterials and Asymmetric Transmon Qubits
Aug-11	Marco Piani	An operational approach to the study of quantum correlations exploiting convex optimization
Aug-19	Ying Dong	Quantum Thermodynamics Based on Optomechanical System
Aug-20	Ibrahim Nsanzineza	Quasiparticles and vortices in superconducting microwave resonators
Aug-26	Nitin Jain	Enabling high-speed quantum communication and foiling quantum hackers
Oct-09	Piotr Migdal	My quantum game - photons and fun
Oct-23	Joseph Salfi	Probing quantum superpositions and correlations at the level of single dopant atoms in a semiconductor
Nov-05	Ankit Garg	A deterministic polynomial time algorithm for word problem for the free skew field
Nov-10	Nai-Hui Chia	How hard is deciding trivial versus non-trivial in the dihedral coset problem
Nov-26	Hao Qin	Side channel attack on a practical continuous-variable quantum key distribution system by inserting an external light
Dec-14	Xingshan Cui	Quantum Max-flow/Min-cut

Dec-16	Edward Chen	Nitrogen-vacancy (NV) centers in diamond nanophotonic structures for quantum networking
Jan-26	Shun Kawakami	Security of differential quadrature phase shift quantum key distribution
Jan-28	Hakop Pashayan	Estimating outcome probabilities of quantum circuits using quasiprobabilities
Feb-08	Dorian Gangloff	Nanocontacts atom-by-atom with a friction emulator
Feb-08	Aye Lu Win	Catalysis of Stark-tuned Interactions between Ultracold Rydberg Atoms
Feb-12	Boris Braverman	Progress toward a spin squeezed optical atomic clock beyond the standard quantum limit
Feb-16	William Paul	Toward single atom qubits on a surface: Pump-probe spectroscopy and electrically-driven spin resonance
Feb-29	K. Rajibul Islam	Measuring Entangle Entropy in a Many-body System
Mar-09	Carl Miller	Quantum Randomness Expansion - New Results
Mar-10	Igor Mekhov	Quantum optics of strongly correlated many-body systems
Mar-24	Archana Kamal	Quantum information processing with superconducting quantum circuits
Mar-28	Crystal Senko	Bottom-up approaches for quantum many-body physics with cold trapped atoms

J. Scientific Visitors

Visitor	Affiliation
Aarthi Sundaram	Centre for Quantum Technologies, National University of Singapore, Singapore
Ajit Singh	Indian National Science Academy, India
Aleksander Kubica	California Institute of Technology, USA
Alvaro Martin-Alhambra	University College London, UK
András Molnár	Max Planck Institute for Quantum Optics, Germany
Andreas Hülsing	Eindhoven University of Technology, Netherlands
Andrew Childs	University of Maryland, USA
Ankit Garg	Princeton University, USA
Anthony Damini	Defence Research and Development Canada / Government of Canada
Anton Zeilinger	University of Vienna, Austria
Archana Kamal	Massachusetts Institute of Technology, USA
Aye Lu Win	Old Dominion University, USA
Badri Younes	National Aeronautics and Space Administration Headquarters, USA
Barry Geldzahler	National Aeronautics and Space Administration Headquarters, USA
Ben Baragiola	University of Mexico, Mexico
Ben Yager	Royal Holloway, University of London, UK
Benjamin Lovitz	Bates College, USA
Bertrand Reulet	University of Sherbrooke, Canada
Bhashyam Balaji	Defence Research and Development Canada / Government of Canada
Boris Braverman	Massachusetts Institute of Technology, USA
Brandon Buonacorsi	University of California, Davis, USA
Britton Plourde	University of Syracuse, USA
Cameron Vickers	University of Connecticut, USA
Carl Miller	University of Michigan, USA
Catherine Laflamme	University of Innsbruck, Austria
Chan Ho Yoon	Columbia University, USA
Cheng Guo	Tsinghua University, China & University of Technology, Sydney
Chris Erven	University of Bristol, UK
Chris Ferrie	The University of Sydney, Australia
Chris Granade	The University of Sydney, Australia
Christian Mastromattei	Queen's University, Kingston, Canada
Christoph Simon	University of Calgary, Canada
Christopher Monroe	University of Maryland, USA

Visitor	Affiliation
Corsin Pfister	Centre for Quantum Technologies, National University of Singapore, Singapore
Cosmic Raj	Tata Institute of Fundamental Research, India
Crystal Senko	Harvard University, USA
Dana Moshkovitz	Massachusetts Institute of Technology, USA
Daniel Terno	Macquarie University, Australia
Dimitrios Antsos	National Aeronautics and Space Administration Headquarters, USA
Dirk van der Marel	University of Geneva, Switzerland
Dominique Pouliot	University of Illinois at Urbana-Champaign, USA
Dong Yang	University of Barcelona, Spain
Dorian Gangloff	Massachusetts Institute of Technology, USA
Edward Chen	Massachusetts Institute of Technology, USA
Emilie Mai Elkiaer	University of Copenhagen, Denmark
Eric Larson	University of Michigan, Ann Arbor, USA
Eric Metodiev	Harvard University, USA
Erik Woodhead	The Institute of Photonic Sciences, Castelldefels (Barcelona), Spain
Ethan Clements	Miami University, USA
Fabian Furrer	Nippon Telegraph and Telephone Basic Research Laboratories, Japan
Fen Liu	Jiaotong University, China
Frank Wilhelm-Mauch	Saarland University, Germany
Franklin Cho	University of Southern California, USA
Fred Shultz	Wellesley College, USA
Frederick Strauch	Williams College, USA
Gaby Lenhart	European Telecommunications Standards Institute, France
Gerardo Ortiz	Indiana University Bloomington, USA
Hakop Pashayan	The University of Sydney, Australia
Hamid Javadi	National Aeronautics and Space Administration Headquarters, USA
Hao Qin	Telecom ParisTech, France
Harry Buhrman	University of Amsterdam, Holland, Netherlands
Helen Fay Dowker	Imperial College London, UK
Heping Zeng	East China Normal University, China
Howard Barnum	University of New Mexico, USA
Ibrahim Nsanzineza	Syracuse University, USA
Igor Mekhov	University of Oxford, UK
Immanuel Bloch	Max Planck Institute of Quantum Optics in Garching, Germany
Jamie Sikora	Centre for Quantum Technologies, National University of Singapore, Singapore

Visitor	Affiliation
Jean-Daniel Bancal	University of Michigan, USA
Jean-Francois Biasse	University of South Florida, USA
Jerry Chow	IBM T.J. Watson Research Center, USA
Jingfu Zhang	Technische Universitat Dortmund, Germany
John Martinis	University of California, Santa Barbara, USA
Jonathan Vandermause	Dartmouth College, USA
Jorma Louko	The University of Nottingham, UK
Joseph Salfi	University of New South Wales, Canberra, Australia
Joshua Levin	Boston University, USA
Juan Carlos Garcia Escartin	Universidad de Valladolid, Spain
Juliana Park	Seoul National University, South Korea
Junan Lin	McGill University, Canada
K. Rajibul Islam	Massachusetts Institute of Technology-Harvard Center for Ultracold Atoms, USA
Karsten Flensberg	Niels Bohr Institute, University of Copenhagen, Denmark
Kathy Prestridge	Los Alamos National Laboratory, USA
Keren Li	Tsinghua University, China
Koon Tong Goh	Centre for Quantum Technologies, National University of Singapore, Singapore
Laura Córdova Matte	Pontifical Catholic University of Rio Grande do Sul,l, Brazil
Liam Pleven	The Wall Street Journal
Lily Chen	National Institute of Standards and Technology, USA
Linghang Kong	Tsinghua University, China
Lu Cong	Jiaotong University, China
Luis Garay	Universidad Complutense, Spain
Marco Piani	University of Strathclyde, Scotland
Mario Berta	California Institute of Technology, USA
Mark Paulsen	Canadian Imperial Bank of Commerce, Canada
Markos Karasamanis	University College London, UK
Markus Grassl	Max Planck Institute for the Science of Light, Germany
Mary P. Hockaday	Los Alamos National Laboratory, USA
Marzio Pozzuoli	Ryerson University, Canada
Matthew Coudron	Massachusetts Institute of Technology, USA
Matthew McKague	University of Otago, New Zealand
Matthieu Nannini	McGill University, Canada
Michele Piscitelli	Royal Holloway, University of London, UK
Ming Lyu	Tsinghua University, China
Minsoo Lee	Korea Institute of Science and Technology, Korea
Mitchell Brickson	Goshen College, USA

Visitor	Affiliation
Morgan Mastrovich	Harvey Mudd College, Claremont California, USA
Mukund Vengalattore	Cornell University, USA
Na Young Kim	Stanford University, USA
Nai-Hui Chia	Pennsylvania State University, USA
Nan Yu	National Aeronautics and Space Administration Headquarters, USA
Nathan Killoran	University of Ulm, Germany
Nitin Jain	Northwestern University, USA
Pablo Rodriguez-Lopez	Laboratoire de Physique Theorique et Modeles Statistiques, France
Pascale Sevigny	Defence Research and Development Canada / Government of Canada
Paul Kwiat	University of Illinois at Urbana-Champaign, USA
Phil Kaye	Government of Canada, Canada
Piotr Kolenderski	Nicolaus Copernicus University, Poland
Piotr Migdal	The Institute of Photonic Sciences, Castelldefels (Barcelona), Spain
Qian Xue	Qingdao University, USA
Qingping Wu	East China Jiaotong University, China
Raj Patel	Griffith University Brisbane, Australia
Rajat Mittal	Indian Institute of Technology, Kanpur, India
Robin Kothari	Massachusetts Institute of Technology, USA
Sadegh Raeisi	Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
Saeqa Vrtilek	Harvard University, USA
Sajeev John	University of Toronto, Canada
Scott Aaronson	Massachusetts Institute of Technology, USA
Sebastian Verschoor	Eindhoven University of Technology, Netherlands
Serge Massar	Université libre de Bruxelles, Belgium
Sevag Gharibian	University of California, Berkeley, USA
Shalev Ben-David	Massachusetts Institute of Technology, USA
Shen Chiu	Defence Research and Development Canada / Government of Canada
Shun Kawakami	The University of Tokyo, Japan
Stacey Jeffery	California Institute of Technology, USA
Stefanie Beale	Acadia University
Stefi Baum	University of Manitoba, Canada
Subrahmanya Vineeth Bhaskara	Indian Institute of Technology Guwahati, India
Tal David	Directorate for Defence Research and Development, Israel
Tan Si-Hui	Singapore University of Technology and Design, Singapore

Visitor	Affiliation
Thomas Kauten	University of Innsbruck, Austria
Tim J. Bartley	National Institute of Standards and Technology, USA
Tommaso Calarco	University of Ulm, Germany
Tony Leggett	University of Illinois at Urbana-Champaign, USA
Tracy Northup	University of Innsbruck, Austria
Urbasi Sinha	Raman Research Institute, India
Valerio Scarani	Centre for Quantum Technologies, National University of Singapore, Singapore
Viv Kendon	Joint Quantum Centre, Durham-Newcastle, UK
Wei Tsen	Columbia University in New York, NY, USA
William Paul	IBM Research, USA
Xiaodong Ma	University of Science and Technology, China
Xingshan Cui	University of California, Santa Barbara, USA
Xingyao Wu	University of Michigan, USA
Yasunobu Nakamura	The University of Tokyo,,Japan
Yihui Quek	Massachusetts Institute of Technology, USA
Ying Dong	Hangzhou Normal University, China
Zhengfang Liu	East China Jiaotong University, China

K. Tours – Industry, Government and Academic

	Date	# of Participants
Academic		
University of Waterloo students of class PHY 467	02-Apr-15	40
King's College London: Jen Angel, Head of International Programmes at King's College London; Luca Vigano, Associate Dean, Mathematics and Natural Sciences	29-May-15	2
University of Strathclyde: Professor Sir Jim McDonald, Vice Chancellor of the University of Strathclyde; Andrew Goudie, Special Advisor to the Vice-Chancellor and Principal; Prof. David Hillier, Dean of the Strathclyde Business School	10-Sep-15	3
Professor Paul Boyle, President and Vice-Chancellor of the University of Leicester	27-Sep-15	1
University of Waterloo Physics students	08-Apr-15	10
King Fahad University of Petroleum and Minerals	01-Jun-15	20
Sorbonne University Delegation	08-Jun-15	10
Elizabeth Bent, from Frederick W. Bent Memorial Graduate Scholarship	23-Jul-15	1
Russell and Ann, CS Grads, donors in department	23-Jul-15	2
NanoMRI Tour group 25	30-Jul-15	30
Tsinghua University Delegation	18-Aug-15	25
Paul Kwiat, University of Illinois, with group from NASA	01-Jun-15	8
Government		
Slovenia ambassador	17-Apr-15	2
Patricia Fuller, Ambassador to Chile	21-Apr-15	2
Their Majesties King Wilhelm and Queen Maxima of the Netherlands; Jet Busseaker, Minister of Education, Culture and Science	28-May-15	4
Brad Duguid, Minister of Economic Development, Employment and Infrastructure, Province of Ontario	08-Jun-15	2
Privy Council Visit: Stephen Lucas, Deputy Secretary to the Cabinet, Plans and Consultations and Intergovernmental Affairs, with team members	23-Jun-15	4
FedDev, IC tour	22-Jul-15	6
Ed Clark, Chair of the Ontario Premier's Advisory Council on Government Assets; Giles Gherson, Deputy Minister and Associate Secretary of the Cabinet, Policy and Delivery, Province of Ontario	14-Aug-15	2
John Knubley, Deputy Minister of Industry Canada; Mitch Davies, Associate Deputy Minister for the Strategic Policy Sector; Mark Lehman, Regional Executive Director, Industry Canada	16-Sep-16	5
Richard Botham, Assistant Deputy Minister, Canada's Economic Development and Corporate Finance Branch	30-Sep-15	2

Bill Mantel, Assistant Deputy Minister, Research and Innovation, Ontario Ministry of Economic Development and Innovation, with group	07-Oct-15	4
Deputy Clerk, City of Toronto	17-Dec-15	1
The Honourable Navdeep Bains, Minister of Innovation, Science and Economic Development; The Honourable Bardish Chagger, Minister of Small Business and Tourism, with group	17-Jan-16	11
Minister Kirsty Duncan; Thitima Songsakul, Regional Manager (Ontario), ISED; Heather Arnold, Policy Analyst, Regional Office (Ontario), ISED	02-Mar-16	3
David Ewert, Ministry of Innovation, Science and Economic Development	03-Mar-16	1
John Tory, Mayor, City of Toronto	23-Mar-16	1
Elizabeth Dowdeswell, Ontario Lieutenant Governor	31-Mar-16	3

Industry

Salim Ismail, Global Ambassador and Founding Executive Director of Singularity, University of California	02-Apr-15	3
Jim and Cindy Colvin	21-Apr-15	2
Deloitte Tour	14-May-15	5
RBC Visit: Bruce Ross, Group Head of Technology and Operations; Regional VP, Francine Dyksterhuis	26-Jun-15	4
Simona Choise, education writer for Globe and Mail	13-Aug-15	3
Chinese Embassy in Ottawa and Chinese Consulate General in Toronto	11-Sep-15	4
Professor Holger Boche, Technische Universität München (TUM); Hartmut Kremling, Vodafone CTO	29-Sep-15	2
Leslie Church, Google Canada's senior PR/Comms lead	22-Oct-15	2
Lisa Lambert from TRIUMF (Canada's National Laboratory for Particle and Nuclear Physics)	01-Dec-15	1
Roy Anthony, Research and Innovation-Christie Digital; Kevin Moule, senior computer scientist	01-Mar-16	2
3M Canada	31-Mar-16	3

L. Earned Media

Date	Media Outlet	Title	URL
04-01-2015	Daily Bulletin	Diamond Jubilee awards for researchers	http://www.bulletin.uwaterloo.ca//2015/apr/01we.html
04-09-2015	Waterloo News	Media Advisory: Canada Excellence Research Chair Meeting at the University of Waterloo	https://uwaterloo.ca/news/news/media-advisory-canada-excellence-research-chair-meeting
04-09-2015	@uwaterloo alumni newsletter	Diamond Jubilee awards for researchers	http://alumni.uwaterloo.ca/alumni/e-newsletter/2015/apr/
04-13-2015	ETSI	Event - 3rd ETSI/IQC Workshop on Quantum-Safe Cryptography	http://www.etsi.org/news-events/events/949-etsi-iqc-3
04-14-2015	Daily Bulletin	CERC meeting focuses on new members	https://uwaterloo.ca/daily-bulletin/2015-04-14
04-16-2015	Daily Bulletin	Research sessions, outreach events conclude CERC meeting	https://uwaterloo.ca/daily-bulletin/2015-04-16
04-23-2015	Morning Exchange	Inaugural Board of Directors chosen for new Waterloo Region Economic Development Corporation (WREDC)	http://www.exchangemagazine.com/morningpost/2015/week16/Thursday/15042302.htm
04-24-2015	CBC.ca	Mike Lazaridis gives $20M to Wilfrid Laurier University for management institute	http://www.cbc.ca/news/canada/kitchener-waterloo/mike-lazaridis-gives-20m-to-wilfrid-laurier-university-for-management-institute-1.3046961
04-27-2015	EurekAlert!	Donation funds expansion of research between leading innovation universities	http://www.eurekalert.org/pub_releases/2015-04/uow-dfe042615.php
04-27-2015	Morning Exchange	Donation funds expansion of research between leading innovation universities	http://www.exchangemagazine.com/morningpost/2015/week17/Monday/15042703.htm
04-27-2015	CBCNews	New management school at Wilfrid Laurier to focus on global business	http://www.cbc.ca/news/canada/kitchener-waterloo/new-management-school-at-wilfrid-laurier-to-focus-on-global-business-1.3049970

Date	Media Outlet	Title	URL
04-27-2015	570 News	Donation to U-W to aid research in treating lung disease & quantum computing	http://www.570news.com/2015/04/27/donation-to-u-w-to-aid-research-in-treating-lung-disease-quantum-computing/?article_id=21162456855
04-29-2015	Wall Street Journal	IBM Brings Quantum Computing a Step Closer	http://blogs.wsj.com/digits/2015/04/29/ibm-brings-quantum-computing-a-step-closer/
04-29-2015	PCWorld	IBM claims advance in effort to build reliable, large-scale quantum computer	http://www.pcworld.com/article/2916392/ibm-claims-advance-in-effort-to-build-reliable-largescale-quantum-computer.html
04-29-2015	MIT Technology Review	IBM Shows Off a Quantum Computing Chip	http://www.technologyreview.com/news/537041/ibm-shows-off-a-quantum-computing-chip/?&article_id=21189058272
04-29-2015	techy type	IBM Brings Quantum Computing a Step Closer	http://techytype.com/news/company-news/tech-ibm-news/ibm-brings-quantum-computing-a-step-closer/
04-29-2015	Kelowna Now	Kelowna Student Chosen Out of Hundreds to Attend Unique Program	http://www.kelownanow.com/watercooler/news/news/Kelowna/15/04/29/Kelowna_Student_Chosen_Out_of_Hundreds_to_Attend_Unique_Program
04-30-2015	Demanjo	IBM advances bring quantum computing closer to reality	http://www.demanjo.com/news/technology/1458578/ibm-advances-bring-quantum-computing-closer-to-reality.html
04-30-2015	Physics4Me	IBM Shows Off a Quantum Computing Chip	http://physicsforme.com/2015/04/30/ibm-shows-off-a-quantum-computing-chip/
04-30-2015	Technology Spectator	IBM pushes quantum computing a step closer	http://www.businessspectator.com.au/news/2015/4/30/technology/ibm-pushes-quantum-computing-step-closer

Date	Media Outlet	Title	URL
04-30-2015	newsmaine	IBM Researchers create Prototype Circuit that could become Basis of Quantum Computers	http://newsmaine.net/23240-ibm-researchers-create-prototype-circuit-could-become-basis-quantum-computers
05-01-2015	Apt 613	So music meets up with quantum mechanics in a bar . . .	http://apt613.ca/so-music-meets-up-with-quantum-physics-in-a-bar/
05-02-2015	Empire State Tribune	IBM's Quantum Leap Technology is Paving the way for the Next Generation of Super Computers	http://www.esbtrib.com/2015/05/02/10945/a-prototype-quantum-computing-circuit-created-by-ibm-will-power-the-computers-of-tomorrow/
05-03-2015	Israelseen.com	Philanthropy funds medical research	http://israelseen.com/2015/05/03/this-weeks-sanity-report-from-israel-may-3-2015/
05-03-2015	The Daily Courier	Grade 11 student headed to Quantum Cryptography school	http://www.kelownadailycourier.ca/news/article_f5417b36-f207-11e4-86d9-9f1721efb2a5.html
05-04-2015	Castanet.net	Local 'Imitation Game'	http://www.castanet.net/edition/news-story-139119-1-.htm#139119
05-04-2015	The Canadian Jewish News	Donation supports Waterloo-Technion research projects	http://www.cjnews.com/?q=node/139314
05-05-2015	Herd Magazine	A Rumour of Androids- When Quantum meets Music	http://www.herdmag.ca/a-rumour-of-androids/
05-06-2015	Nanotechnology Now	New JEOL E-Beam Lithography System to Enhance Quantum NanoFab Capabilities	http://www.nanotech-now.com/news.cgi?story_id=51441
05-07-2015	Solid State Technology	New JEOL e-beam lithography system to enhance Quantum NanoFab capabilities	http://electroiq.com/blog/2015/05/new-jeol-e-beam-lithography-system-to-enhance-quantum-nanofab-capabilities/

Date	Media Outlet	Title	URL
05-11-2015	Globe & Mail	Social media campaign aims to raise profile of Canadian research	http://www.theglobeandmail.com/news/national/social-media-campaign-aims-to-raise-profile-of-canadian-research/article24362332/
05-11-2015	Frogheart (BLOG)	Research2Reality: a science media engagement experience dedicated to Canadian science	http://www.frogheart.ca/?p=16825
05-12-2015	Daily Bulletin	Research2Reality: a science media engagement experience dedicated to Canadian science	https://uwaterloo.ca/daily-bulletin/2015-05-12
05-12-2015	EurekAlert!	Researchers theoretically demonstrate detection of spin of atoms at room temperature	http://www.eurekalert.org/pub_releases/2015-05/uow-rtd051215.php
05-15-2015	Chemeurope.com	Researchers theoretically demonstrate detection of spin of atoms at room temperature	http://www.chemeurope.com/en/news/152847/researchers-theoretically-demonstrate-detection-of-spin-of-atoms-at-room-temperature.html
05-15-2015	Lab Product News	Discovery could pave way to new approaches to medical diagnostics	http://www.labcanada.com/news/discovery-could-pave-way-to-new-approaches-to-medical-diagnostics/1003627676/?&er=NA
05-18-2015	PR Web	Innovations Airs New Episode on Monday, May 25, 2015 Via Discovery Channel	http://www.prweb.com/releases/2015/04/prweb12676788.htm
05-18-2015	7th space interactive	DMG Productions explores the latest technological breakthroughs in science and technology	http://7thspace.com/headlines/508969/dmg_productions_explores_the_latest_technological_breakthroughs_in_science_and_technology.html
05-18-2015	Innovations with Ed Begley, Jr.	Innovations Airs New Episode on Monday, May 25, 2015 Via Discovery Channel	http://innovationstelevision.com/uncategorized/innovations-airs-new-episode-on-monday-may-25-2015-via-discovery-channel/

Date	Media Outlet	Title	URL
05-19-2015	PR Web	Operational Note: King and Queen of the Netherlands to Visit Waterloo	http://www.digitaljournal.com/pr/2558500
05-19-2015	CBCNews	King and Queen of the Netherlands to visit Waterloo Region May 28	http://www.cbc.ca/news/canada/kitchener-waterloo/king-and-queen-of-the-netherlands-to-visit-waterloo-region-may-28-1.3078983
05-19-2015	Digital Journal	Operational Note: King and Queen of the Netherlands to Visit Waterloo	http://www.digitaljournal.com/pr/2558500
05-20-2015	Everythingzoomer.com	King Willem-Alexander and Queen Maxima to visit Canada	http://www.everythingzoomer.com/king-willem-alexander-and-queen-maxima-to-visit-canada/#.VV3WZllVhBc
05-20-2015	Female First	King Willem-Alexander and Queen Maxima to visit Canada	http://www.femalefirst.co.uk/royal_family/king-willem-alexander-queen-maxima-visit-canada-802973.html
05-20-2015	Wikian Theological Foundation	Photons in curved space-time	https://aharonbrodutch.wordpress.com/tag/iqc/
05-20-2015	Brampton Guardian	Dutch king and queen to visit Waterloo Region	http://www.bramptonguardian.com/news-story/5634503-dutch-king-and-queen-to-visit-waterloo-region/
05-21-2015	Phys.Org	Researchers theoretically demonstrate detection of spin of atoms at room temperature	http://phys.org/news/2015-05-theoretically-nuclear-room-temperature.html
05-25-2015	Record	A Dutch treat awaits the region	https://app.infomart.com/intranet/full_view/topic/news/107735/tn|107735|kwrc|20150525|221204860/496/935
05-25-2015	National Post	5 things to watch; the Dutch Royals in Canada	https://app.infomart.com/intranet/full_view/topic/news/107735/tn|107735|ntnp|20150525|221197902/496/935

Date	Media Outlet	Title	URL
05-25-2015	TV Eyes.com	Transcript	http://mms.tveyes.com/transcript.asp?StationID=660&DateTime=5%2F25%2F2015+7%3A32%3A28+AM&PlayClip=true
05-25-2015	Daily Bulletin	Monday's notes	https://uwaterloo.ca/daily-bulletin/2015-05-25
05-26-2015	The Globe and Mail	Education partnership on the agenda during Dutch mission to Canada	http://www.theglobeandmail.com/news/national/education-partnership-on-the-agenda-during-dutch-mission-to-canada/article24633160/
05-26-2015	CBCNews	Dutch royals kick off Canadian visit with YYT stop	http://www.cbc.ca/news/canada/newfoundland-labrador/dutch-royals-kick-off-canadian-visit-with-yyt-stop-1.3088140
05-26-2015	Daily Bulletin	Preparations and protocols for tomorrow's royal visit	https://uwaterloo.ca/daily-bulletin/2015-05-27
05-26-2015	Waterloo Homepage	Waterloo historian reflects on the liberation of the Netherlands	https://uwaterloo.ca/stories/waterloo-historian-reflects-liberation-netherlands
05-26-2015	Waterloo Homepage	Liberating the Netherlands: The story behind a Canadian soldier killed in battle	https://uwaterloo.ca/stories/liberating-netherlands-story-behind-canadian-soldier-killed
05-27-2015	Xinhua News	Dutch royals visit Canada to mark 70th anniversary of WWII liberation	http://news.xinhuanet.com/english/2015-05/28/c_134278105.htm
05-27-2015	Critical Mention	(Video)	http://beta.criticalmention.com/bits/wordplay/#/clipId=14006584&slim=1&partnerToken=0c0ecf0c-6c8e-444d-bc05-dd8da1ef5571
05-27-2015	Hello! Canada	King Willem-Alexander and Queen Máxima touch down in Canada	http://ca.hellomagazine.com/royalty/02015052716470/king-willem-alexander-queen-maxima-canada

Date	Media Outlet	Title	URL
05-28-2015	Waterloo News	Dutch royals visit, witness new research and education partnership between leading universities	https://uwaterloo.ca/news/news/dutch-royals-visit-witness-new-research-and-education
05-28-2015	Waterloo Homepage	Dutch royal couple charms crowds at the University of Waterloo	https://uwaterloo.ca/stories/dutch-royal-couple-charms-crowds-university-waterloo
05-28-2015	Waterloo Homepage	Quantum researcher awarded Dutch liberation scholarship	https://uwaterloo.ca/stories/quantum-researcher-awarded-dutch-liberation-scholarship
05-28-2015	CTV Kitchener	Waterloo hosts royals	http://kitchener.ctvnews.ca/video?clipId=623634
05-28-2015	CTV News	Waterloo hosts royals	http://www.ctvnews.ca/canada/dutch-royalty-award-70-scholarships-to-canadian-students-1.2395829
05-28-2015	570 News	PHOTOS: Dutch Royalty visit Waterloo Region	http://www.570news.com/2015/05/28/photos-dutch-royalty-visit-waterloo-region/
05-28-2015	Hello! Daily Magazine	Queen Máxima of the Netherlands dazzles in ruby tiara during Canadian tour	http://us.hellomagazine.com/royalty/1201505284965/queen-maxima-ruby-tiara-canadian-tour
05-28-2015	Record	Dutch visit to University of Waterloo commemorates Canada-Netherlands bond	http://www.therecord.com/news-story/5649476-dutch-visit-to-university-of-waterloo-commemorates-canada-netherlands-bond/
05-29-2015	Morning Exchange	Dutch royals visit, witness new research and education partnership between leading universities	http://www.exchangemagazine.com/morningpost/2015/week21/Friday/15052911.htm
05-29-2015	Global News	King Willem-Alexander, Queen Maxima of the Netherlands visit Toronto today	http://globalnews.ca/news/2024545/king-willem-alexander-queen-maxima-of-the-netherlands-visit-toronto-today/

Date	Media Outlet	Title	URL
05-29-2015	Canada AM	(Video)	http://beta.criticalmention.com/bits/wordplay/#/keyword=University%20of%20waterloo&uuid=4f2668b3-5910-4e56-b745-eb2904e865ff&channelId=7044&minTime=20150529100000&maxTime=20150529130000&token=0c0ecf0c-6c8e-444d-bc05-dd8da1ef5571
05-29-2015	University Affairs	New Dutch scholarships a thank you to Canada	http://www.universityaffairs.ca/news/news-article/new-dutch-scholarships-a-thank-to-canada/
06-02-2015	CPA Magazine	Quantum valley	https://cpacanada.ca/en/connecting-and-news/cpa-magazine/articles/2015/June/quantum-valley
06-03-2015	TEREPAC	Terepac Corporation Teams with IQC and evolutionQ	http://www.terepac.com/#!/news/cybersecurity
06-03-2015	CNW	Terepac Corporation Teams with IQC and evolutionQ	http://www.newswire.ca/en/story/1549107/terepac-corporation-teams-with-iqc-and-evolutionq
06-03-2015	Financial Review	Terepac Corporation Teams with IQC and evolutionQ	http://financialreview.biz/news/terepac-corporation-teams-with-iqc-and-evolutionq
06-04-2105	Record	Quantum partnership focuses on cybersecurity	http://www.therecord.com/news-story/5662352-quantum-partnership-focuses-on-cybersecurity/
06-05-2015	Cyber Security Caucus	Quantum partnership focuses on cybersecurity	http://cybersecuritycaucus.com/quantum-partnership-focuses-on-cybersecurity/
06-18-2015	Waterloo News	Twenty-six University of Waterloo researchers receive prestigious research awards	https://uwaterloo.ca/news/news/twenty-six-university-waterloo-researchers-receive

Date	Media Outlet	Title	URL
06-21-2015	Daily Trust	A glance at quantum computing	http://www.dailytrust.com.ng/daily/index.php/it-world/57775-a-glance-at-quantum-computing
06-26-2015	Maclean's	Canada's science performance, down the memory hole	http://www.macleans.ca/politics/ottawa/canadas-science-performance-down-the-memory-hole/
06-27-2015	Frogheart (BLOG)	D-Wave passes 1000-qubit barrier	http://www.frogheart.ca/?tag=institute-of-qunatum-computing-iqc
06-28-2015	Stratford Beacon Herald	Canadian physicist Raymond Laflamme discusses harnessing the power of curiosity at Stratford Festival	http://www.stratfordbeaconherald.com/2015/06/28/canadian-physicist-raymond-laflamme-discusses-harnessing-the-power-of-curiosity-at-stratford-festival-forum-event
06-29-2015	Forbes	What's The Point Of Science Without 'Eureka!' Moments?	http://www.forbes.com/sites/chadorzel/2015/06/29/whats-the-point-of-science-without-eureka-moments/
06-30-2015	Globe and Mail	Theoretical Physics is a low-cost, high-yield investment	http://www.theglobeandmail.com/report-on-business/rob-commentary/theoretical-physics-is-a-low-cost-high-yield-investment/article25187460/
06-30-2015	Epoch Times	4 Common Misconceptions About Quantum Physics	http://www.theepochtimes.com/n3/1410931-4-common-misconceptions-about-quantum-physics/
07-09-2015	@uwaterloo alumni newsletter	Canadian physicist Raymond Laflamme discusses harnessing the power of curiosity at Stratford Festival	http://alumni.uwaterloo.ca/alumni/e-newsletter/2015/jul/?utm_source=enews_organic&utm_medium=enews&utm_campaign=july2015

Date	Media Outlet	Title	URL
07-14-2015	Communitech News	Politics Plug-in: Advice for young companies from GR veteran Bob Crow	http://news.communitech.ca/columns/politics-plug-in-advice-for-young-companies-from-gr-veteran-bob-crow/
07-24-2015	Inside Halton.com	Oakville teen studied with select group of brilliant students	http://www.insidehalton.com/news-story/5750553-oakville-teen-studied-with-select-group-of-brilliant-students/
07-26-2015	North Shore News	Teen masters physics, one particle at a time	http://www.nsnews.com/teen-masters-physics-one-particle-at-a-time-1.2012418
07-27-2015	Waterloo Homepage	Nanotech experts hope to take detailed pictures of molecules	https://uwaterloo.ca/stories/nanotech-experts-hope-take-detailed-pictures-molecules
07-27-2015	Daily Bulletin	Scientists gather for NanoMRI conference this week	https://uwaterloo.ca/daily-bulletin/2015-07-27
07-30-2015	Bloomberg News	Alibaba Secures Data Centers With Quantum Research Lab	http://www.bloomberg.com/news/articles/2015-07-30/alibaba-secures-data-centers-with-quantum-research-lab
08-04-2015	Waterloo Homepage	Internet security: Creating crytpotgraphic tools for the quantum age	https://uwaterloo.ca/stories/internet-security-creating-crytpotgraphic-tools-quantum-age
08-04-2015	Le Monde	70 ans après Hiroshima : « Une cyberattaque quantique aurait un effet dévastateur sur nos vies »	http://www.lemonde.fr/sciences/article/2015/08/04/70-ans-apres-hiroshima-une-cyberattaque-quantique-aurait-un-effet-devastateur-sur-nos-vies_4711594_1650684.html
08-17-2015	Daily Bulletin	Monday's notes	https://uwaterloo.ca/daily-bulletin/2015-08-17
Aug-15	The CTT Triangle	Quantum encryption	http://archive.constantcontact.com/fs114/1110081848662/archive/1121800813832.html

Date	Media Outlet	Title	URL
09-01-2015	Motherboard	Countdown to the Crypto-Apocalypse	http://motherboard.vice.com/en_ca/read/countdown-to-the-crypto-apocalypse
09-02-2015	New Scientist	Can we get energy from nothing?	https://www.newscientist.com/article/mg22730370-800-can-we-get-energy-from-nothing/
09-08-2015	Nature	Online security braces for quantum revolution	http://www.nature.com/news/online-security-braces-for-quantum-revolution-1.18332
09-08-2015	uWaterloo	Four Waterloo professors named Royal Society of Canada fellows	https://uwaterloo.ca/news/news/four-waterloo-professors-named-royal-society-canada-fellows
09-08-2015	The Globe and Mail	Wilfrid Laurier University names business school for Mike Lazaridis	http://www.theglobeandmail.com/report-on-business/wilfrid-laurier-university-names-business-school-for-mike-lazaridis/article26243756/
09-08-2015	Laurier	Laurier names School of Business & Economics after visionary technology entrepreneur Mike Lazaridis	http://www.wlu.ca/media/news-releases/september-2015/laurier-names-school-of-business-and-economics-after-visionary-technology-entrepreneur-mike-lazaridis.html
09-08-2015	Laurier	Announcing the Lazaridis School of Business & Economics	https://www.youtube.com/watch?v=9zKeQTOqEHs
09-08-2015	The Record	Laurier names business school for Mike Lazaridis	http://www.therecord.com/news-story/5831901-laurier-business-school-named-for-mike-lazaridis/
09-08-2015	Scientific American	Cryptographers Brace for Quantum Revolution	http://www.scientificamerican.com/article/cryptographers-brace-for-quantum-revolution/

Date	Media Outlet	Title	URL
09-08-2015	Quanta Magazine	A Tricky Path to Quantum-Safe Encryption	https://www.quantamagazine.org/20150908-quantum-safe-encryption/
09-09-2015	Daily Exchange	Four Waterloo professors named Royal Society of Canada fellows	http://www.exchangemagazine.com/morningpost/2015/week36/Wednesday/15090910.htm
09-09-2015	CTV Kitchener	Economy, security top issues for Harper at Kitchener stop	http://kitchener.ctvnews.ca/economy-security-top-issues-for-harper-at-kitchener-stop-1.2555533
Sept/Oct 15	Exchange Magazine	Challenge Accepted	http://www.exchangemagazine.com/currentissue/ExchangeVol33No1/ExchangeVol33No1-spread.pdf
09-19-2015	Wired	The Tricky Encryption That Could Stump Quantum Computers	http://www.wired.com/2015/09/tricky-encryption-stump-quantum-computers/
09-22-2015	Cambridge Times	Eliminating barriers to job creation in Kitchener South-Hespeler	http://www.cambridgetimes.ca/news-story/5923150-elminating-barriers-to-job-creation-in-kitchener-south-hespeler/
09-22-2015	Musical Toronto	Music Director Edwin Outwater Says Goodbye to the Kitchener-Waterloo Symphony	http://www.musicaltoronto.org/2015/09/22/the-scoop-music-director-edwin-outwater-says-goodbye-to-the-kitchener-waterloo-symphony/
09-23-2015	EurekAlert!	Twisting neutrons - JQI	http://www.eurekalert.org/pub_releases/2015-09/jqi-tn092115.php
09-24-2015	EurekAlert!	A twist for control of orbital angular momentum of neutron waves - Waterloo	http://www.eurekalert.org/pub_releases/2015-09/uow-atf092415.php
09-23-2015	Phys.Org	Twisting neutrons: Orbital angular momentum of neutron waves can be controlled	http://phys.org/news/2015-09-neutrons-orbital-angular-momentum-neutron.html

Date	Media Outlet	Title	URL
09-24-2015	University of Waterloo News	A twist for control of orbital angular momentum of neutron waves	https://uwaterloo.ca/news/news/twist-control-orbital-angular-momentum-neutron-waves
09-24-2015	Globe & Mail	University of Ottawa prof named as possible Nobel Prize winner	http://www.theglobeandmail.com/news/national/university-of-ottawa-prof-named-as-possible-nobel-prize-winner/article26508660/
09-24-2015	State of Innovation	The 2015 Thomson Reuters Citation Laureates	http://stateofinnovation.thomsonreuters.com/citation-laureates-2015
09-24-2015	(e) Science News	A twist for control of orbital angular momentum of neutron waves	http://esciencenews.com/articles/2015/09/24/a.twist.control.orbital.angular.momentum.neutron.waves
09-25-2015	Quantum Computing Technology Australia	Opportunity to Combine Quantum Control of Neutrons with The Study and Engineering of Quantum Materials	http://www.quantumcomputingtechnologyaustralia.com/2015/09/25/opportunity-to-combine-quantum-control-of-neutrons-with-the-study-and-engineering-of-quantum-materials/www-quantumcomputingtechnologyaustralia-com-105/
09-25-2015	Space Dailly	Twisting neutrons	http://www.spacedaily.com/reports/Twisting_neutrons_999.html
09-25-2015	cantech letter	Ottawa physicist tipped to win Nobel for enabling selfie-taking molecules	http://www.cantechletter.com/2015/09/ottawa-physicist-tipped-to-win-nobel-for-enabling-selfie-taking-molecules/
10-05-2015	University of Waterloo News	New Quantum Cats game launches to build better understanding of quantum concepts	https://uwaterloo.ca/news/news/new-quantum-cats-game-launches-better-understanding-quantum

Date	Media Outlet	Title	URL
10-05-2015	Phys.Org	New Quantum Cats game launches to build better understanding of quantum concepts	http://phys.org/news/2015-10-quantum-cats-game-concepts.html
10-05-2015	softpedia	Quantum Cats Is a Fun Way to Learn Quantum Science	http://news.softpedia.com/news/quantum-cats-is-a-fun-way-to-learn-quantum-science-493715.shtml
10-05-2015	Daily Bulletin	2,345 Quantum Cats were herded on Saturday	https://uwaterloo.ca/daily-bulletin/2015-10-05
10-05-2015	EurekAlert!	New Quantum Cats game launches for better understanding of quantum concepts	http://www.eurekalert.org/pub_releases/2015-10/uow-nqc100415.php
10-07-2015	Maclean's	Talking points: On Nobel prizing and future driving	http://www.macleans.ca/news/need-to-know/talking-points-on-nobel-prizing-and-future-driving/
10-08-2015	NewStatesman	Code breaking's quantum leap – you have been warned	http://www.newstatesman.com/culture/observations/2015/10/code-breaking-s-quantum-leap-you-have-been-warned
10-08-2015	Daily Bulletin	Recapping Reunion 2015	https://uwaterloo.ca/daily-bulletin/2015-10-08
10-09-2015	CIFAR News & Ideas	CIFAR Researchers appointed to the Royal Society of Canada and RSC College	http://knowledgecircle.cifar.ca/cifar-researchers-appointed-to-the-royal-society-of-canada-and-rsc-college/
10-13-2015	Imprint	Angry Birds and quantum science converge at IQC	http://www.uwimprint.ca/article/5375-angry-birds-and-quantum-science-converge
10-13-2015	CBC Hamilton	Mars colonizer more hopeful about mission with discovery of water	http://www.cbc.ca/news/canada/hamilton/news/mars-colonizer-more-hopeful-about-mission-with-discovery-of-water-1.3268350

Date	Media Outlet	Title	URL
10-14-2015	Industry tap into news	New Long Distance, Fiber Based, Quantum Teleportation Record Set	http://www.industrytap.com/new-long-distance-fiber-based-quantum-teleportation-record-set/32047
10-16-2015	physicsworld.com	Quantum Cats, physicists and stamp collecting, extraterrestrial building work	http://blog.physicsworld.com/2015/10/16/quantum-cats-physicists-and-stamp-collecting-extraterrestrial-building-work/
10-20-2015	physcis4thecool.com	Schrö	http://www.physics4thecool.com/2015/10/schro.html
10-20-2015	Press Release Point	Yale Quantum Institute to launch	http://www.pressreleasepoint.com/yale-quantum-institute-launch
10-22-2015	Globe & Mail	How Canada can nurture growth through tech and innovation	http://www.theglobeandmail.com/report-on-business/rob-commentary/how-canada-can-nurture-growth-through-tech-and-innovation/article26930666/
10-24-2015	Motherboard	Quantum Encryption Is No Match for a Scorching Laser Beam, Researchers Find	http://motherboard.vice.com/read/a-new-quantum-hack-just-burns-a-hole-right
10-28-2015	The Cord	Glowing response to new exhibit	http://www.thecord.ca/glowing-response-to-new-exhibit/
10-28-2015	Yale News	Introducing the Yale Quantum Institute and the start of the 'Second Information Age'	http://news.yale.edu/2015/10/28/introducing-yale-quantum-institute-and-start-second-information-age
10-31-2015	AZO Optics	Light Illuminated' Exhibit Invites Visitors to Explore Role of Light in our Daily Lives	http://www.azooptics.com/News.aspx?newsID=21754
11-01-2015	Record	Waterloo teen takes on Einstein, world takes notice	http://www.therecord.com/news-story/6075600-waterloo-teen-takes-on-einstein-world-takes-notice/

Date	Media Outlet	Title	URL
11-02-2015	CBC.ca	Two Ontario teens among the finalists for $250K Breakthrough scholarship	http://www.cbc.ca/news/canada/kitchener-waterloo/two-ontario-teens-among-the-finalists-for-250k-breakthrough-scholarship-1.3299520
11-02-2015	University of Nottingham	Academic affiliated with Institute for Quantum Computing, University of Waterloo	http://www.nottingham.ac.uk/mathematics/news/academic-affiliated-with-institute-for-quantum-computing,-university-of-waterloo.aspx
11-03-2015	Gizmodo	There's Always More Room at the Quantum Hilbert Hotel	http://gizmodo.com/physicists-can-add-rooms-to-a-quantum-hilbert-hotel-1737852148
11-10-2015	Grand Magazine	Just a matter of time	http://www.pressreader.com/canada/grand-magazine/20151110/281797102871551/TextView
11-12-2015	FreshGhana.com	NIST Team Proves 'Spooky Action during a Distance' is Really Real	http://freshghana.com/nist-team-proves-spooky-action-at-a-distance-is-really-real/
11-12-2015	Science Daily	Spooky action at a distance' is really real	http://www.sciencedaily.com/releases/2015/11/151112123650.htm
11-13-2015	Waterloo News	Waterloo graduate students win Vanier scholarships for transformational research at Waterloo	https://uwaterloo.ca/news/news/waterloo-graduate-students-win-vanier-scholarships
11-17-2015	Morning Exchange	Waterloo graduate students win Vanier scholarships for transformational research at Waterloo	http://www.exchangemagazine.com/morningpost/2015/week46/Tuesday/15111716.htm#anchor
11-17-2015	Globe & Mail	Harnessing quantum law for new technologies	10199_2015PR/GlobeMail_ExcellenceinResearch.pdf
11-18-2015	uWaterloo	UN Year of Light: Waterloo grad students create light exhibit	https://uwaterloo.ca/stories/year-light-waterloo-grad-students-create-light-exhibit

Date	Media Outlet	Title	URL
11-22-2015	The Toronto Star	How Canada reversed the 'brain drain'	http://www.thestar.com/news/insight/2015/11/22/the-great-gets.html
11-24-2015	Record - Tech Spotlight	Startups pave way for quantum computer future; "There are people who are forward thinking and want to be ahead of the curve."	https://app.infomart.com/intranet/full_view/topic/news/107735/tn|107735|kwrc|20151124|234364092/496/935
11-24-2015	proof	Equation Series: John Fish	http://proofwaterloo.com/equation-series-john-fish/
11-25-2015	Maclean's	Ten steps to make Canada a leader in science	http://www.macleans.ca/politics/ottawa/ten-steps-to-make-canada-a-leader-in-science/
11-29-2015	I Programmer	Quantum Cats	http://www.i-programmer.info/news/112-theory/9218-quantum-cats.html
12-01-2015	Canadian Business	Canada shows a "disturbing" decline in innovation and R&D	http://www.canadianbusiness.com/innovation/canada-shows-a-disturbing-decline-in-innovation-and-rd/
December 2015	IBM	A quantum of possibilities	http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=XB&infotype=PM&htmlfid=OIE03005USEN&attachment=OIE03005USEN.PDF
12-04-2015	3D Perspectives	Quantum leap	http://perspectives.3ds.com/tag/quantum-computing/
12-13-2015	Epoch Times	Quantum Physics Just Got Less Complicated	http://www.theepochtimes.com/n3/1918238-quantum-physics-just-got-less-complicated/
12-16-2015	Daily Bulletin	Waterloo makes a solid CASE for communications excellence	https://uwaterloo.ca/daily-bulletin/2015-12-16
12-16-2015	APS Physics	Viewpoint: Closing the Door on Einstein and Bohr's Quantum Debate	http://physics.aps.org/articles/v8/123

Date	Media Outlet	Title	URL
12-17-2015	The Sydney Morning Herald	Quantum Physics for Babies: Mark Zuckerberg reads his daughter a book by Sydney author Dr Chris Ferrie	http://www.smh.com.au/entertainment/books/quantum-physics-for-babies-mark-zuckerberg-reads-his-daughter-a-book-by-sydney-author-dr-chris-ferrie-20151217-glnrf5.html
12-24-2015	Nature Photonics	Quantum optics: Arithmetic with photons	http://www.nature.com/nphoton/journal/v10/n1/full/nphoton.2015.253.html
12-27-2015	Chathamdailynews.ca	Chatham native's book a hit with Zuckerberg family	http://www.chathamdailynews.ca/2015/12/27/chatham-natives-book-a-hit-with-zuckerberg-family
Jan-Feb 2016	Exchange Magazine	A Baker's Dozen from Exchange	http://www.exchangemagazine.com/currentissue/ExchangeVol33No3/ExchangeVol33No3.pdf
January 2016	.@Uwaterloo	Waterloo makes a solid CASE for communications excellence	https://uwaterloo.ca/daily-bulletin/2015-12-16
01-21-2016	University of Cambridge Research	Artificial intelligence and rise of the machines: Cambridge Science Festival 2016science-festival-2016#sthash.M4QvvsrS.009gtFCr.dpuf	http://www.cam.ac.uk/research/news/artificial-intelligence-and-rise-of-the-machines-cambridge-science-festival-2016
01-25-2016	The Register	MIT boffin: Big data won't compute? Try these handy quantum algorithms	http://www.theregister.co.uk/2016/01/25/mit_boffin_claims_a_novel_quantum_approach_to_big_data/
01-25-2016	CIO	When big data gets too big, this machine-learning algorithm may be the answer	http://www.cio.com/article/3026225/what-happens-when-big-data-gets-too-big-quantum-computers-may-hold-the-key.html
01-26-2016	Cambridge Network	Artificial intelligence and rise of the machines: Cambridge Science Festival 2016	http://www.cambridgenetwork.co.uk/news/ai-rise-of-machines-cambridge-science-festival-2016/
01-27-2016	TechCentral.ie	Machine learning algorithm tackles even bigger data	http://www.techcentral.ie/machine-learning-algorithm-tackles-even-bigger-data/

Date	Media Outlet	Title	URL
01-29-2016	Bitcoin News Channel	Quantum Computing and the Future of Bitcoin Cryptography - Part 1	http://bitcoinnewschannel.com/2016/01/29/quantum-computing-the-future-of-bitcoin-cryptography-part-i/
02-05-2016	Foreignaffairs.co.nz	Could a quantum approach help with big data?	http://foreignaffairs.co.nz/2016/02/05/could-a-quantum-approach-help-with-big-data/
02-08-2016	Science and Technology Research News	Contemplating a Quantum Future	http://www.sciceandtechnologyresearchnews.com/contemplating-a-quantum-future/
02-09-2016	Waterloo News	$5.2 million awarded to five Canada Research Chairs at Waterloo	https://uwaterloo.ca/news/news/52-million-awarded-five-canada-research-chairs-waterloo
02-09-2016	CBCNews	9 professors in Waterloo and Guelph named Canada Research Chairs	http://www.cbc.ca/news/canada/kitchener-waterloo/canada-research-chairs-2016-university-of-waterloo-guelph-1.3440753
02-09-2016	Goli Tube	Explained: Quantum Computing	http://www.golitube.com/watch.php?vid=4c12f2b5a
02-10-2016	Exchange Magazine	$5.2 million awarded to five Canada Research Chairs at Waterloo	http://www.cbc.ca/news/canada/kitchener-waterloo/canada-research-chairs-2016-university-of-waterloo-guelph-1.3440753
02-09-2016	Ontario Canada	What every investor needs to know about quantum computing	http://www.investinontario.com/spotlights/what-every-investor-needs-know-about-quantum-computing
02-11-2016	Daily Bulletin	$5.2 million awarded to new Canada Research Chairs	https://uwaterloo.ca/daily-bulletin/2016-02-11
02-19-2016	Entrevestor	Pioneers in Quantum Computing	http://entrevestor.com/kw/blog/pioneers-in-quantum-computing/

Date	Media Outlet	Title	URL
02-22-2016	New Universe Daily	Researchers Demonstrate New Interpretation of Quantum Mechanics	http://newuniversedaily.com/2016/02/22/researchers-demonstrate-new-interpretation-of-quantum-mechanics/?utm_content=bufferda65d&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer
02-19-2016	CIFAR.ca	Researchers demonstrate 'quantum surrealism'	http://www.cifar.ca/assets/researchers-demonstrate-quantum-surrealism/
02-22-2016	International Business Times	Quantum Weirdness Gives Way to Intuitive Behavior In New Experiment	http://www.ibtimes.com/quantum-weirdness-gives-way-intuitive-behavior-new-experiment-2316822
02-20-2016	Nanotechnology Now	Researchers demonstrate 'quantum surrealism'	http://www.nanotech-now.com/news.cgi?story_id=53027
02-19-2016	Phys.Org	Researchers demonstrate 'quantum surrealism'	http://phys.org/news/2016-02-quantum-surrealism.html
02-22-2016	Morning Ticker	Breakthrough: Scientists describe the weird world of quantum surrealism	http://www.morningticker.com/2016/02/breakthrough-scientists-describe-the-weird-world-of-quantum-surrealism/
March/April 2016	Exchange Magazine	Through the lens of opportunity	http://www.exchangemagazine.com/currentissue/ExchangeVol33No4/ExchangeVol33No4.pdf
03-07-2016	NorthernLife.ca	Local filmmaker wins writing competition	http://www.northernlife.ca/news/localNews/2016/03/07-local-film-maker-wins-sudbury.aspx
03-10-2016	CIFAR Ideas Exchange	CIFAR fellows among new Canada Research Chairs	http://www.cifar.ca/assets/recent-awards-and-honours-march-2016/?mc_email=true
03-15-2016	Metro	Federal heritage minister in Halifax to announce funding for Canada's 150th anniversary	http://www.metronews.ca/news/halifax/2016/03/15/federal-heritage-minister-in-halifax-to-announce-funding.html

Date	Media Outlet	Title	URL
03-15-2016	Perimeter Institute	Perimeter heads nationwide partnership to ignite innovation for Canada's 150th year	http://perimeterinstitute.ca/news/perimeter-heads-nationwide-partnership-ignite-innovation-canadas-150th-year
03-15-2016	Newswire	Nationwide partnership ignites the innovator in all of us for Canada's 150th year	http://www.newswire.ca/news-releases/nationwide-partnership-ignites-the-innovator-in-all-of-us-for-canadas-150th-year-572097951.html
03-15-2016	CTV Atlantic	Canada's a year away from marking...	http://atlantic.ctvnews.ca/video?clipId=823691&binId=1.1145729&playlistPageNum=1
03-15-2016	CBC Halifax	Melanie Joly...	http://www.cbc.ca/player/play/2685354476
03-15-2016	CBC Halifax	Heritage Minister Mélanie Joly says investing in arts will help grow the economy	http://www.cbc.ca/news/canada/nova-scotia/melanie-joly-economy-heritage-minister-arts-and-culture-nova-scotia-1.3408932
03-15-2016	Nova Scotia Chronicle Herald	Federal cash targeted for Canada’s 150th birthday	http://thechronicleherald.ca/novascotia/1349438-federal-cash-targeted-for-canada%E2%80%99s-150th-birthday
03-15-2016	Ottawa Festivals.ca	A promising future thanks to youth and innovation	http://www.ottawafestivals.ca/the-150th-anniversary-of-confederation-in-2017-its-happening-right-here/
03-15-2016	The Signal	Innovation 150 looks to inspire youth for Canada’s 150th anniversary	http://signalhfx.ca/innovation-150-looks-to-inspire-youth-for-canadas-150th-anniversary/
03-17-2016	Daily Bulletin	Institute for Quantum Computing joins Innovation150	https://uwaterloo.ca/daily-bulletin/2016-03-17#institute-for-quantum-computing-joins-innovation150

Date	Media Outlet	Title	URL
03-20-2016	Toronto Star	Stratford Festival reports third surplus in a row	http://www.thestar.com/entertainment/stage/2016/03/20/stratford-festival-reports-third-surplus-in-a-row.html
03-21-2016	Cambridge Network	Cambridge Science Festival 2016: artificial intelligence stole the show	http://www.cambridgenetwork.co.uk/news/science-festival-16-artificial-intelligence-stole-show/
03-23-2016	EET Asia	Postcards from a quantum computing lab	http://www.eetasia.com/ART_8800720564_499489_NT_30862b32.HTM
03-23-2016	Waterloo Chronicle	Celebrating the sensational	http://www.waterloochronicle.ca/whatson-story/6402754-celebrating-the-sensational/
03-24-2016	Invest in Ontario	Perimeter Institute's Neil Turok recognized for championing fundamental science	http://www.investinontario.com/spotlights/perimeter-institutes-neil-turok-recognized-championing-fundamental-science
03-24-2016	CBC News - Kitchener-Waterloo	Salary list spreads 'sunshine' on top university, college earners	http://www.cbc.ca/news/canada/kitchener-waterloo/sunshine-list-university-salaries-2016-1.3506731
03-30-2016	Phys.Org	Quantum computing with single photons getting closer to reality	http://phys.org/news/2016-03-quantum-photons-closer-reality.html
03-30-2016	HNGN	Quantum Computing Breakthrough Brings Single Photon Sources Within Reach	http://www.hngn.com/articles/193905/20160330/quantum-computing-breakthrough-brings-single-photon-sources-within-reach.htm
03-30-2016	Opli	Advancing quantum technologies one chip at a time	http://www.opli.net/opli_magazine/eo/2016/advancing-quantum-technologies-one-chip-at-a-time-march-news/

M. Governance

Below is a biography for individuals currently servicing on IQC's Executive Committee, Board of Directors and Scientific Advisory Committee.

Executive Committee

George Dixon, Vice President, Chair, University Research, University of Waterloo

George Dixon is Vice-President, University Research and Professor of Biology at the University of Waterloo. Professor Dixon has received both the Award for Excellence in Research and the Distinguished Teaching Award from the university. He has over 25 years experience in aquatic toxicology and environmental risk assessment and management. He maintains an active research program, which is focused methods for environmental effects monitoring, methods of assessing the environmental risks associated with exposure of aquatic organisms to metal mixtures, and on the aquatic environmental effects of oil sands extraction in Alberta. He is Associate Editor of three scientific journals, including the Canadian Journal of Fisheries and Aquatic Sciences.

Stephen Watt, Dean, Faculty of Mathematics, University of Waterloo

Stephen M. Watt is Dean of the Faculty of Mathematics and Professor in the David R. Cheriton School of Computer Science at the University of Waterloo. He previously held the title of Distinguished University Professor at Western University where he served for periods as Chair of the Department of Computer Science and Director of the Ontario Research Centre for Computer Algebra. Prior to this, he held positions at the IBM T.J. Watson Research Center in Yorktown Heights (USA) and INRIA and the University of Nice (France). Professor Watt's areas of research include algorithms and systems for computer algebra, programming languages and compilers, mathematical handwriting recognition and document analysis. He was one of the original authors of the Maple and Axiom computer algebra systems, principal architect of the Aldor programming language and its compiler at IBM Research, and is co-author of the MathML and InkML W3C standards. Watt was a co-founder of Maplesoft in 1988 and served on its board of directors from 1998 to 2009. He served on the board of directors of the Descartes Systems Group from 2001 to 2015, including two periods as Board Chair. He presently serves on the boards of Waste Diversion Ontario, which oversees the management of all Ontario's recycling programs, and of the McMichael Canadian Art Foundation. Professor Watt is the recipient of numerous distinctions, including Doctor Honoris Causa from the University of the West (Romania), the J.W. Graham Medal in Computing and Innovation (Waterloo) and the Outstanding Innovation Award (IBM).

Raymond Laflamme, Executive Director, Institute for Quantum Computing

Raymond Laflamme was born in Quebec City and did his undergraduate studies in Physics at Universite Laval. He then moved to Cambridge, England, where he survived Part III of Mathematical Tripos before earning his PhD in the Department of Applied Mathematics and Theoretical Physics (DAMTP) under the direction of Stephen Hawking. Laflamme and Don Page are responsible for having changed

Hawking's mind on the direction of time in a contracting Universe (as described in Hawking's best-seller "A Brief History of Time"). After his PhD, Laflamme became a Killam post-doctoral fellow at the University of British Columbia, where he met his future wife Janice Gregson. He moved back to Cambridge in 1990 as a Research Fellow at Peterhouse. He finally settled down for nine years at Los Alamos National Laboratory. He arrived as a postdoctoral fellow, then became an Oppenheimer Fellow in 1994, just after the birth of his son Patrick. His daughter Jocelyne was born in 1995. In 2001 he joined the Perimeter Institute for Theoretical Physics as a founding member. He has founded the Institute for Quantum Computing with Michele Mosca and has been its Executive Director since 2002.

Bob Lemieux, Dean of Science, University of Waterloo

Dr. Bob Lemieux joined Waterloo as the Dean of Science starting July 1, 2015. Previous to his appointment here, he was a professor in the Department of Chemistry and served as Associate Dean (Research) in the Faculty of Arts and Science at Queen's University. Bob Lemieux came with proven experience as an administrator, researcher, mentor and teacher. His passion for teamwork and collaboration has helped him create a culture of synergistic partnerships across academic units and faculties. Lemieux has been a faculty member of Department of Chemistry at Queen's University since 1992. His multi-disciplinary research into designing advanced liquid crystal materials found in high-performance microdisplays has earned him several international recognitions, including the 2012 Samsung Mid-Career Award and the Ontario Premier's Research Excellence Award. He is co-investigator on a CREATE grant. Lemieux received the Chemistry departmental teaching award twice as well as the W.J. Barnes Teaching Excellence Award from the Queen's Arts and Science Undergraduate Society. Lemieux was Head of the Chemistry Department for five years and Associate Dean (Research) in the Faculty of Arts and Science at Queen's University, and has also been involved in the recruitment of a Canada Excellence Research Chair.

Wayne J. Parker, Acting Dean, Faculty of Engineering, University of Waterloo

Dr. Wayne J. Parker is a professor in the Civil and Environmental Engineering Department at the University of Waterloo, and is cross appointed Director of Centre for Control of Emerging Contaminants (CCEC). Currently, he is the Acting Dean for the Faculty of Engineering. Dr. Parker holds a Ph.D. in Civil Engineering from the University of Waterloo. Some of his research interests are Anaerobic membrane bioreactors for wastewater and sludge treatment; fate of emerging contaminants in wastewater systems; pretreatment of sludges for enhanced digestion; advanced sludge digestion processes; nutrient recovery from wastewater. Before coming to Waterloo, Dr. Parker was an Associate Professor at Carleton University.

Robert Crow, Executive in Residence, Institute for Quantum Computing

Robert E. (Bob) Crow is an experienced public policy and technology industry leader, currently serving as Executive in Residence at the Institute for Quantum Computing (IQC), University of Waterloo.

Bob's career includes lengthy service in the private, Non Governmental Organization (NGO), and university sectors as an executive, consultant and teacher. He is especially known as a strategic thinker and builder of organizational capacity in settings where technology and public policy intersect. A frequent speaker, Bob is an informed and articulate advocate for his organizations and their missions. Bob is the former Vice-President for Industry, Government and University Relations at Research In Motion Limited (RIM), where he built and led RIM's global programs in government relations, community relations, corporate responsibility, market intelligence and university research. Bob's teams supported RIM's rapid international expansion from 2001 – 2011 and were especially noted for their ability to create and defend access to foreign markets, often under challenging circumstances. Prior to joining RIM in July 2001, Bob was Vice-President Policy at the Information Technology Association of Canada (ITAC) where he successfully positioned ITAC as a business association of credibility and influence in the Canadian policy milieu. Prior to this, he served from 1975 – 1998 at Ryerson University in Toronto as both professor of planning and senior administrator in a wide variety of roles including Information and Communication Technology strategy development, establishment of a technology centre, and leader of Ryerson's advancement activities.

Bob holds a bachelor's degree in engineering from Cornell University and master's degrees in planning and economics from the University of North Carolina at Chapel Hill and the University of Toronto, respectively. He also studied engineering and public policy at Carnegie Mellon University at the advanced graduate level.

Kevin Resch, Deputy Director, Academic, Institute for Quantum Computing

Kevin Resch received the BSc (Hon.) degree in Chemical Physics from Queen's University, Kingston, Canada, in 1997. He received the MSc and PhD degrees in Physics from the University of Toronto, Canada, in 1998 and 2002 respectively. His Masters and Doctoral theses were based on experimental quantum optics and completed under the supervision of Aephraim Steinberg. Subsequently, Kevin held a Natural Sciences and Engineering Research Council of Canada (NSERC) Postdoctoral Fellowship with Anton Zeilinger's group at the University of Vienna, Austria and a Research Fellow position with Andrew White's Quantum Technology Laboratory at the University of Queensland, Brisbane, Australia. He joined the University of Waterloo's physics department and the Institute for Quantum Computing (IQC) in 2006.

Board of Directors

Mike Lazaridis (Board Chair) Co-founder and Managing Partner, Quantum Valley Investments

Mike Lazaridis is the founder of telecommunications company Blackberry (formerly Research In Motion). He served as Vice Chair of the company's Board, and Chair of the Board's new Innovation Committee. IQC was launched in 2002 thanks to the vision and incredible philanthropy of Lazaridis, who has given more than $105 million

to the institute since inception. He is also the founder of Waterloo's Perimeter Institute for Theoretical Physics.

Tom Brzustowski, RBC Professor, Telfer School of Management, University of Ottawa

Tom Brzustowski graduated with a B.A.Sc. in Engineering Physics from the University of Toronto in 1958, and a PhD in Aeronautical Engineering from Princeton in 1963. He was a professor in the Department of Mechanical Engineering at the University of Waterloo from 1962 to 1987. He served as Chair of Mechanical Engineering from 1967 to 1970 and as Vice President, Academic of the university from 1975 to 1987. He served as deputy minister in the Government of Ontario from 1987 to 1995. He was appointed President of NSERC in October 1995, and reappointed in 2000. He is an Officer of the Order of Canada and a fellow of the Canadian Academy of Engineering and of the Royal Society of Canada.

George Dixon, Vice President, Chair, University Research, University of Waterloo

Complete biography listed under Executive Committee.

Raymond Laflamme (ex-officio), Executive Director, Institute for Quantum Computing

Complete biography listed under Executive Committee.

Robert Crow, Executive in Residence, Institute for Quantum Computing

Complete biography listed under Executive Committee.

Robert Dunlop, Retired, Industry Canada

Robert recently retired from Industry Canada where he was the assistant deputy minister responsible for science and innovation. He held this position between 2009 and 2014, and before that he served at the assistant deputy minister level at Finance Canada where he co-managed the Economic Development and Corporate Finance Branch. Over his career he had responsibilities in a number of areas including program management, policy development and supporting ministers.

Robert is a native Montrealer where he studied economics and finance at McGill University. He now lives in Toronto.

Cosimo Fiorenza, VP and General Counsel, Quantum Valley Investments

Cosimo Fiorenza is the Vice-President and General Counsel of the Quantum Valley Investments and the Quantum Valley Investment Fund. He is actively involved at several public and private non-profit and charitable institutions in addition to Institute for Quantum Computing, including the Perimeter Institute, the Law Society of Upper Canada, the Centre for International Governance Innovation, and several private family foundations. Mr. Fiorenza holds a degree in Business Administration from Lakehead University and a law degree from the University of Ottawa.

Mark Pecen, CEO, Approach Infinity Inc.

Mark Pecen serves as CEO of Approach Infinity, Inc., providing advisory services to firms requiring technology due diligence and management consulting in the areas of wireless communication and emerging technologies, rapidly growing technology companies and their venture capital funding partners. The firm comprises a network of senior executives and experts in the management of technology, innovation, research and development, marketing, sales, global standards, patents, technology entrepreneurship, and individuals with specific technical disciplines such as information theory, radio frequency systems, wireless system protocols, cryptography and others. Pecen retired as Sr. Vice President, Research and Advanced Technology and technology advisor to the CEO of BlackBerry, maker of wireless smart phones. He was responsible for the creation and management of BlackBerry's Advanced Technology Research Centre and a significant portion of BlackBerry's wireless patent portfolio. A past Distinguished Innovator and member of the Science Advisory Board at Motorola, Pecen also managed consultation work for clients in North America and Europe.

Peter Hackett, Professor, University of Alberta

Peter Hackett has been President and CEO of Alberta Ingenuity since October 2004. He is the former Vice-President Research at the National Research Council of Canada where he led NRC corporate strategies emphasizing emerging technologies, entrepreneurship and technology clusters. He was the lead NRC executive behind the creation and design of the National Institute for Nanotechnology at the University of Alberta. He is a member of the Institute Advisory Board Institute of Genetics, the Canadian Institute of Health Research, a board member of Genome Alberta and a founding member of the Alberta Advisory Committee on the Bio-economy. He was honoured recently by a Specially Elected Fellow of the Royal Society of Canada (RSC).

David Fransen, Former Consul General Canadian Consulate in Los Angeles

David Fransen worked from 1985 to 1988 at the Privy Council Office, where he provided policy advice related to such developments as the Green Plan in 1990, the drafting of the Canadian Environmental Assessment Act and the Canadian Environmental Protection Act, and the creation of the Canadian Environmental Assessment Agency. He then became Director of Economic Framework Policies in the Strategic Policy Branch of Industry Canada. In 1999, David became the Director General of the Centre for Healthy Human Development at Health Canada. He became Assistant Deputy Minister of the Industry Sector in 2003, where he was primarily responsible for providing policy advice and delivering programs related to some of Canada's key economic sectors. He became a member of the board of the Institute for Quantum Computing in 2006. He was most recently the Consul General, Canadian Consulate General in Los Angeles.

Peter E. Brown, Senior Practice Partner, Deloitte Canada

Peter E. Brown, CPA CA, ICD.D., is a Senior Practice Partner in Deloitte Canada. Peter has close to 30 years' experience in public accounting, serving clients in both the public and private sectors. He has gained significant international experience in assurance and advisory services and has extensive experience with business advisory services. Peter served as Managing Partner for Deloitte's Atlantic Practice until 2008 when Peter relocated to Toronto to assume the role of Managing Partner and National Leader for Private Company Services. In 2011, Peter's responsibilities were expanded to include the entire middle market for Deloitte Canada. In 2013 Peter relinquished these responsibilities and was appointed to Deloitte Canada's Client Cabinet which is comprised of senior leaders with firm wide market responsibilities. Peter is the co-author of The Power of The Best, published in September 2012, the sequel to Building the Best - Inside Canada's Best Managed Companies. Peter is a frequent speaker on topics of entrepreneurship and what makes Best Managed companies unique. Peter has also served on the Board of Directors for Deloitte Canada. Peter has a broad range of expertise in issues unique to entrepreneurs in privately held companies and to globally oriented mid-market companies. He also has extensive experience in leadership, strategic planning, mergers and acquisitions, and succession planning. His clients ranged from family owned businesses to global organizations in various industries, including transportation, consumer business, technology, real estate, professional services, and mining services. Peter's current portfolio of clients includes Fortis, Hatch, Stikeman Elliott LLP, Smart Centres, Spin Master and Major Drilling Group International Inc. Peter has been involved in United Way both in the Atlantic Region and Toronto, in Chambers of Commerce throughout Atlantic Canada, and is a member of the Advisory Board for the Sobeys School of Business. Peter is also involved in Habitat for Humanity and served as part of a Deloitte Humanitarian Team that travelled to Brazil in October of 2011 to build homes and meet with local business leaders. Peter is a graduate of St. Mary's University and is a member of the Canadian and Ontario Institutes of Chartered Accountants and a CPA (Illinois). Peter is a graduate of the Directors Education Program offered by the Institute of Corporate Directors and Rotman School of Management.

Scientific Advisory Committee

Prof. Harry Buhrman, Centrum voor Wiskunde en Informatica (CWI)

Harry Buhrman is head of the research group 'Algorithms and Complexity' at the Centrum Wiskunde & Informatica, which he joined in 1994. Since 2000 he also has a joint appointment as full professor of computer science at the University of Amsterdam. Buhrman's research focuses on quantum computing, algorithms, complexity theory, and computational biology. One of the highlights in the work of Buhrman is the article co-authored with Richard Cleve (University of Waterloo, Canada) 'Quantum Entanglement and Communication Complexity'. They demonstrated that with quantum entanglement certain communication tasks can be solved more efficiently. He also co-developed a general method to establish the

limitations of quantum computers. He has written more than 100 scientific publications.

Prof. Anthony Leggett, University of Illinois at Urbana-Champaign

Anthony J. Leggett, the John D. and Catherine T. MacArthur Professor and Center for Advanced Study Professor of Physics, has been a faculty member at Illinois since 1983. He was a co-winner of the 2003 Nobel Prize in Physics for pioneering work on superfluidity. He is a member of the National Academy of Sciences, the American Philosophical Society, the American Academy of Arts and Sciences, the Russian Academy of Sciences (foreign member), and is a Fellow of the Royal Society (U.K.), the American Physical Society, and the American Institute of Physics. He is an Honorary Fellow of the Institute of Physics (U.K.). He was knighted (KBE) by Queen Elizabeth II in 2004 "for services to physics." He is also a Mike and Ophelia Lazaridis Distinguished Research Chair.

Prof. Chris Monroe, University of Maryland

Christopher Monroe is an experimental atomic, molecular and optical physicist. Monroe obtained his PhD at the University of Colorado in 1992. From 1992-2000, Monroe was a postdoc and staff physicist in the Ion Storage Group of David Wineland at the National Institute of Standards and Technology in Boulder, CO. In 2000, Monroe moved to the University of Michigan, where he introduced the use of single photons to couple quantum information between atomic ions. In 2006, he became Director of the FOCUS Center at the University of Michigan. In 2007, Monroe became the Bice Sechi-Zorn Professor of Physics at the University of Maryland and a Fellow of the new Joint Quantum Institute between Maryland and NIST. In 2007-2008, Monroe's group succeeded in producing quantum entanglement between two widely separated atoms and teleported quantum information between atoms separated by a large distance.

Umesh Vazirani, University of California

Umesh Vazirani is a professor in the Computer Science Division of the Department of Electrical Engineering and Computer Sciences at the University of California, Berkeley. Professor Vazirani is a Director of the Berkeley Quantum Information and Computation Center (BQIC). He received an NSF Presidential Young Investigator Award in 1987 and the Friedman Mathematics Prize in 1985. Professor Vazirani wrote the book, “An Introduction to Computational Learning Theory" with Michael Kearns and currently is at the forefront of research in the area of quantum computing.

Prof. Anton Zeilinger, University of Vienna

Anton Zeilinger is a professor of physics at the University of Vienna (previously Innsbruck). Professor Zeilinger is known for multiple experiments in the realm of quantum interferometry and the demonstration of quantum teleportation. His work influenced the experimental progress in a new sub-field of physics, quantum information theory. He has contributed to theoretical physics and the foundations of

quantum mechanics — he has showed an amplification of the Einstein-Podolsky-Rosen paradox, where one considers three, instead of just two, entangled particles.

Prof. Wojciech Zurek, Los Alamos National Laboratory

Wojciech Hubert Zurek is a Laboratory Fellow at Los Alamos National Laboratory (LANL). He is a leading authority on a number of physics topics, including quantum theory, and particularly, decoherence. His work also has great potential benefit to the emerging field of quantum computing. He was educated in Krakow, Poland (M.Sc. 1974) and Austin, Texas (PhD 1979). He spent two years at Caltech as a Tolman Fellow, and began his appointment at LANL as a J. Oppenheimer Fellow. He was the leader of the Theoretical Astrophysics Group at LANL from 1991 until he was made a Laboratory Fellow in the Theory Division in 1996. Zurek is currently a foreign associate of the Cosmology Program of the Canadian Institute for Advanced Research.

N. Administrative Staff

IQC Administrative Staff as of March 31, 2016:

Jeannie Bairos
Erica Boland
Cory Brown
Eric Choi
Sara Clark
Sean Collins
Matt Cooper
Robert Crow
Tobi Day-Hamilton
Monica Dey
Christine Dietrich
Kathryn Fedy
Melissa Floyd
Matthew Fries
Brian Goddard
Ryan Goggin
Mohammad Hamoodi
Lorna Kropf
Kimberly Kuntz
Raymond Laflamme
Martin Laforest
Chin Lee
Xinhua Ling
Vito Logiudice
Scott McManus
Shravan Mishra
Jessica Miranda
Mai-Britt Mogensen
Brian Neill
Nathan Nelson-Fitzpatrick
Angela Olano
Mary Lyn Payerl
Jose (Roberto) Romero
Rodello Slandanan
Matthew Schumacher
Matt Scott
Jodi Szimanski
Dylan Totzke
Carly Turnbull
Steve Weiss