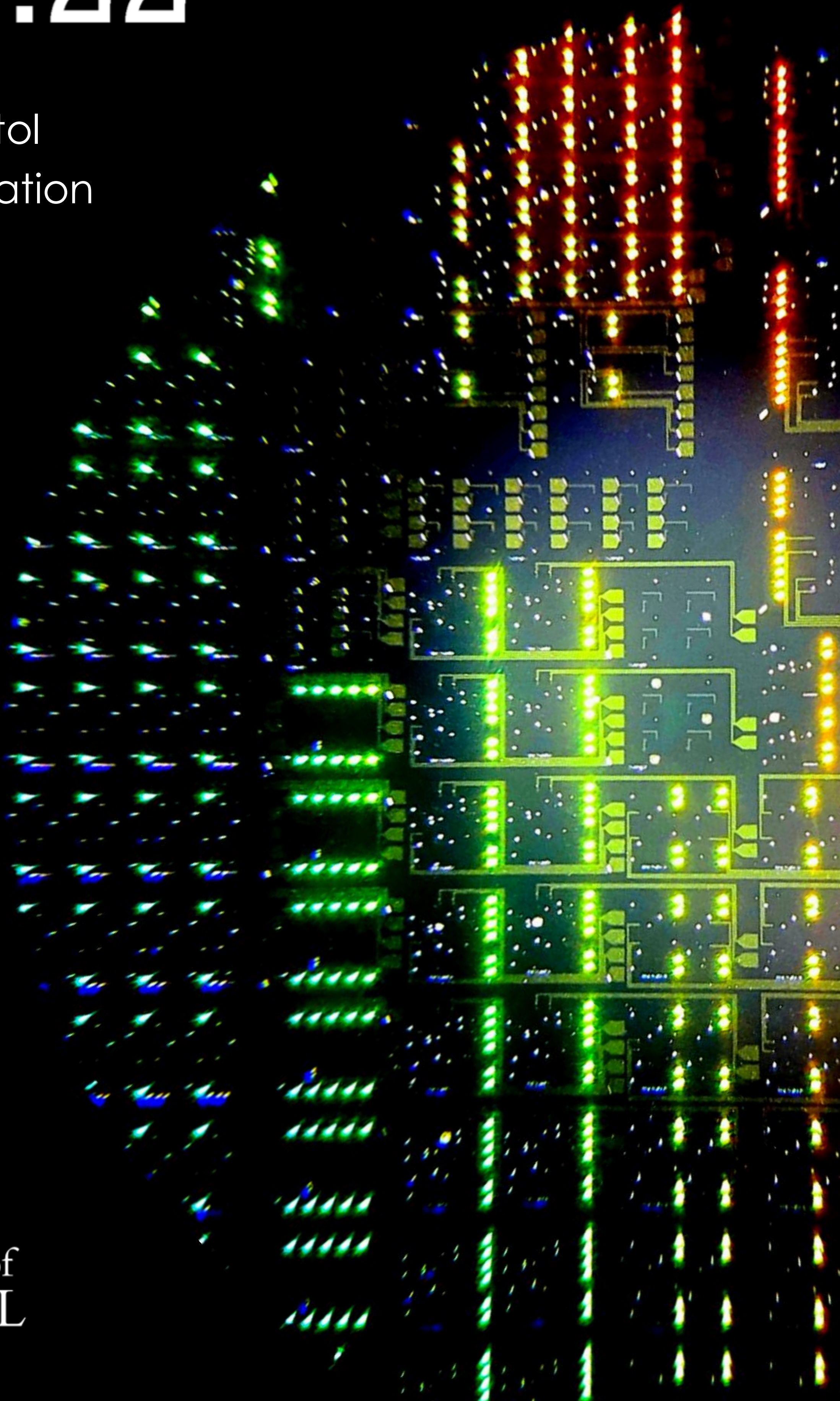
BQIT:22

Ninth Annual Bristol Quantum Information Technologies Workshop

25-28 April 2022



QET Labs

University of Bristol

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PROGRAMME COVER IMAGE: ALEXANDRE MAINOS (UNIVERSITY OF BRISTOL)

CODE OF CONDUCT

The BQIT team is dedicated to providing a harassment-free hybrid conference experience for everyone, regardless of gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion (or lack thereof) or technology choices. We do not tolerate harassment of workshop participants in any form. Sexual language and imagery is not appropriate for any workshop platform, including talks, panels, dinners, Twitter and other online media. Workshop participants violating these rules may be sanctioned or expelled from BQIT:22 at the discretion of the workshop organisers.

WELCOME TO BQIT:22

The BQIT:22 team welcomes you to the ninth Bristol Quantum Information Technologies workshop.

After having been tested in countless experiments over a number of decades as a physical theory, Quantum Mechanics is now being tested as a basis to build new commercially viable quantum technologies. Over the nine years the BQIT workshop has been running, we have seen a large acceleration in this transition from experimental testing to commercialisation, and the pace only seems to be picking up. The applications currently being commercialised are for computing and simulations, communications and cryptography and metrology, sensing and imaging. A strong aim of BQIT is to grow the relationship between academia and industry so that new innovations can be translated from the lab and into the world where they can benefit society.

This year is the first time in our workshop's history that we will run as a hybrid event. The global circumstances that continue to impact us all professionally and personally forced BQIT to be delivered as an all-virtual workshop in 2020 and 2021. This year we are delighted that we can welcome attendees back to Bristol both in person and virtually for our ninth workshop. After many lessons learned and valuable feedback from our previous attendees and organisers, we have organised this year's workshop keeping in mind the benefits of what it means to 'go online', whilst maintaining the 'best bits' of an in-person event. The access this creates to colleagues across the world who would otherwise be unable to join us means that we look to welcome many more attendees to BQIT than previous years, and connects with colleagues we otherwise may not have been able to reach. We look forward to BQIT's poster sessions, whose access is available via our virtual platform, with a number of physical posters at our event venue. Our workshop continues to benefit from written Q&A sessions with our presenters, allowing all attendees the equal chance to have their voices heard. Our sponsors will also be exhibiting online, with a number also showcasing their companies at our in-person venue. We recognise the extra energy required to stay connected and motivated during these difficult times, and are hugely encouraged to see so many of you willing to continue to connect with us on an online platform. We are, of course, also thrilled to see so many of you in person after such a long break.

It is our hope that you have a productive and enjoyable time while you engage and interact with BQIT:22. To everyone that has helped take BQIT:22 hybrid, thank you!

Holly Caskie, Jonathan Matthews & Anthony Laing, on behalf of the BQIT board

VENUE & PARKING

Great Eastern Hall, SS Great Britain

Great Western Dockyard, Gas Ferry Rd, Bristol BS1 6TY

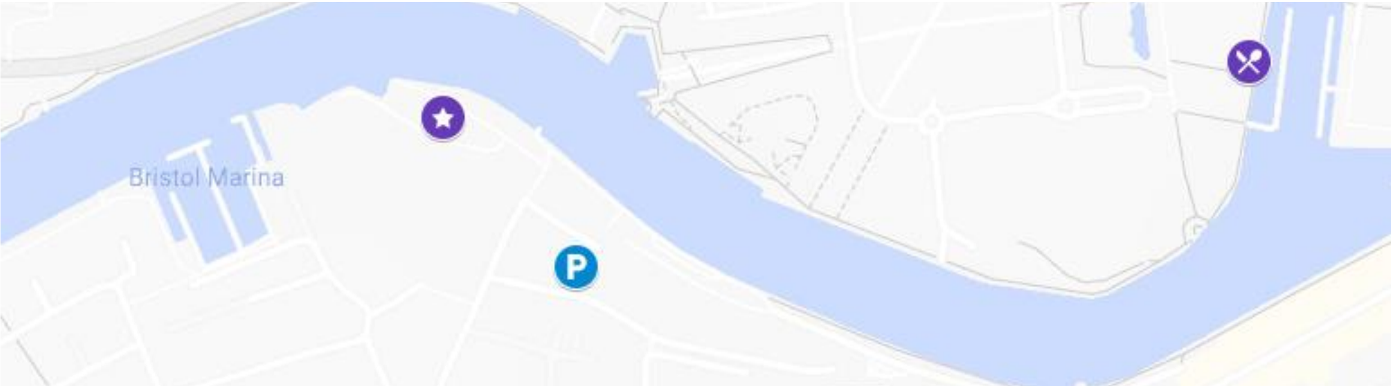
The in-person component of BQIT:22 will be held in the Great Eastern Hall at the SS Great Britain, with break out space and an exhibition area in additional rooms.

Parking is available in the SS Great Britain car park next to our event venue.

Drinks and canapes will be served at our event venue following the poster session on the first day of our workshop (Tuesday 26 April) at 6pm. We invite all hybrid workshop registrants to join us for an evening of networking to celebrate the opening our ninth (and first hybrid!) annual workshop.

We would like to take this opportunity to thank our friends at the SS Great Britain for accommodating our workshop at the eleventh hour, and for doing so with incredible understanding and flexibility. It has been a joy to work with you and we look forward to spending the next few days together!

We would also like to extend our best wishes to We the Curious, where we had originally planned to hold our workshop. Sadly, two weeks before our event, We the Curious suffered fire damage to their roof just above the event suite. The events team went above and beyond to ensure we were taken care of and to help us find a new place to hold BQIT:22. We wish the team a safe and swift journey back to business as usual.



WORKSHOP DINNER

Revolucion de Cuba

Bordeaux Quay, Bristol BS1 5EP

If you have registered for this year's conference dinner, we invite you to join us at Revolucion de Cuba following Day Two of our workshop (Wednesday 27 April). Drinks will be served at 6pm, with dinner at 7pm.

Revolucion de Cuba can be found across the harbour, a short 15 minute walk (or ferry ride!) away.

If you have not registered for our dinner, but are interested in attending, please speak to someone at our reception desk, or email us at bqit-admin@bristol.ac.uk.

University of BRISTOL

Quantum Technologies Innovation Centre

The Quantum Technologies Innovation Centre (QTIC) offers exceptional facilities and support services for quantum and deep tech companies to **launch, grow and connect.**

The Centre is based at the University of Bristol's 1 Cathedral Square in the centre of Bristol with strong links to the local business support and scientific research ecosystem.

"QTIC has all the right ingredients that enable us to use their network and build new links. The labs and equipment are fantastic – there is nothing comparable for quantum and quantum service companies in the UK."

- Dr Josh Silverstone,

Qontrol

Laboratory Space

Benches from **£650 pcm + VAT**

- Flexible shared and dedicated laboratory spaces
- Access to equipment pool including oscilloscopes, optical and RF sources*
- Option to request new equipment for the shared pool
- Hackspace with 3D printers, hand tools and soldering stations at £10 p/day
- Cleanroom and fabrication services*
- Meeting rooms and breakout spaces
- Fully serviced building with 24/7 access

**Subject to additional costs*

Office and Workspaces

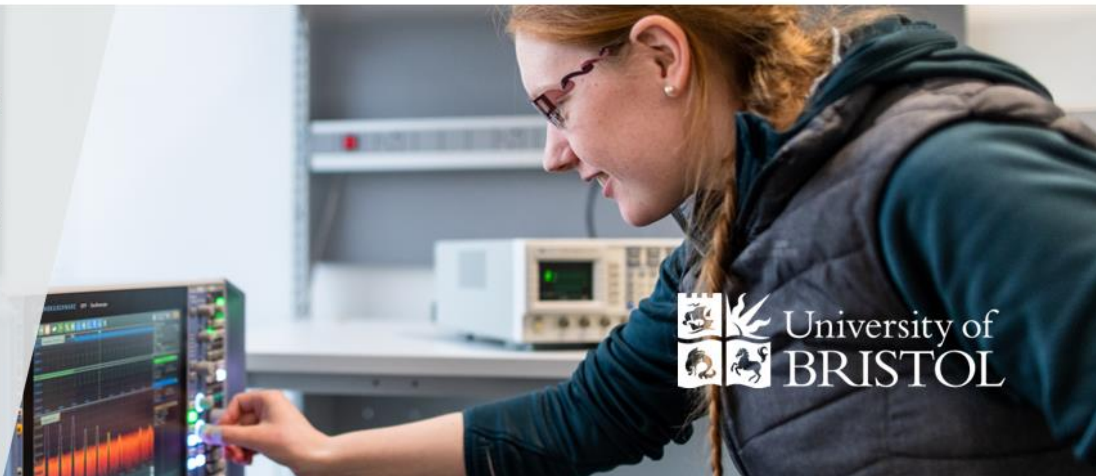
Desks from **£350 pcm + VAT**

- Kitchen, lockers and showers
- Card access bike park
- Meeting rooms and breakout spaces
- Fully serviced building with 24/7 access
- Use of Engine Shed Members' lounge

Enquire about space

qtic-info@bristol.ac.uk

bristol.ac.uk/qtic



TUTORIAL SESSION

MONDAY APRIL 25

TIME	EVENT	LENGTH
10.00	Alex Belsley (University of Bristol) *Welcome*	10 min
Tutorial One: chaired by Eleni Diamanti (CNRS)		
10.10	Ulrik Lund Andersen (Technical University of Denmark) *Continuous Variables Optical Quantum Computing*	60 min
11.10	Virtual lab tours	30 min

If you are attending the tutorial day in person, we invite you to join us for lunch at 12pm in the NSQI Building Foyer.

Tutorial Two: chaired by Owain Strassburg (University of Bristol)		
13.00	Carrie Weidner (University of Bristol) *Quantum Optimal Control in Ultracold Atomic Sensors*	60 min
Tutorial Three: chaired by Vinita Mittal (University of Bristol)		
14.30	Tony Short (University of Bristol) *Quantum Thermodynamics*	60 min
15.30	Virtual lab tours	30 min

16.00 TUTORIAL DAY CLOSE

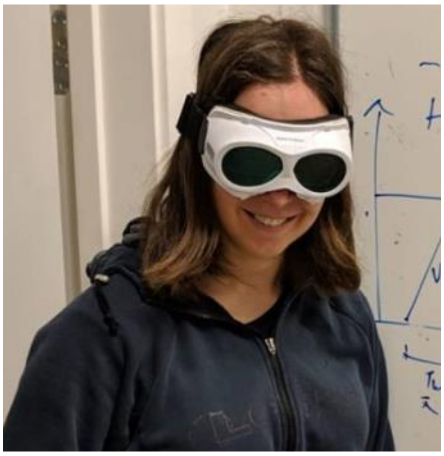
TUTORIAL ABSTRACTS

Ulrik Lund Andersen

Technical University of Denmark

Continuous Variables Optical Quantum Computing

Quantum computing can be realized with numerous different hardware platforms and using different computational protocols. One highly promising strategy to foster scalability is to use an optical platform combined with a measurement-induced quantum processing protocol where the computational gates are realized through optical measurements on a multi-partite continuous variable entangled state. In this tutorial, I will discuss the basic principles of continuous variable optical quantum computing with a particular focus on measurement-based computation, universality and fault-tolerance.



Carrie Weidner

University of Bristol

Quantum Optimal Control in Ultracold Atomic Sensors

As quantum technologies proliferate amidst the second quantum revolution, the question of optimal control of these systems arises, especially in cases where controls are difficult to glean analytically. Furthermore, cold and ultracold atoms are a fantastic platform for quantum technologies, including quantum sensors. In this tutorial, I will broadly discuss the practicalities of how cold and ultracold atoms are made and their utility as quantum sensors (specifically inertial sensors), using my own work in ultracold atom interferometry as a framing point. Then, from that framing point, I will dive into quantum optimal control from both a theoretical and experimental point of view, focusing on practical implementations and tips that any researcher can use to supplement their work. In particular, I will focus on the myriad of mistakes that I made as I was learning to control my atoms in the hopes of teaching you what NOT to do. After this tutorial, you should have a basic idea of what your cold atom physicist friends are talking about when they describe their work and a basic starting knowledge of how to practically implement quantum optimal control in your work.

Tony Short

University of Bristol

Quantum Thermodynamics

Thermodynamics was invented to deal with macroscopic machines such as steam engines, long before the discovery of quantum theory. However, there has recently been a growing interest in how thermodynamics applies in the quantum regime – even to individual quantum systems such as a single molecule. In such cases, we can construct a framework which yields similar thermodynamic results to the classical case, using tools from quantum information theory. This tutorial will present this simple framework for quantum thermodynamics and show how it can be used to derive the thermodynamic laws. We will also explore alternative definitions of heat and work, and extensions of the framework.

DAY ONE AGENDA

TUESDAY APRIL 26

TIME	EVENT	LENGTH
09.20	Alex Clark(University of Bristol) *Welcome and opening of the workshop*	10 min
Session One: chaired by Molly Thomas (University of Bristol)		
09.30	Sheng-Kai Liao (USTC) *Satellite based Quantum Key Distribution network*	25 min
09.55	Anna Pappa (TU Berlin) *Anonymity in Quantum Conference Key Agreement*	25 min
10.20	Mariella Minder (University of Oxford) *Advances in repeater-like quantum communications*	25 min
10.45	Sophie Hermans (QuTech) *Three diamond quantum processors, two entangled links, one multi-node quantum network*	25 min
Session Two: chaired by Tiff Brydges (University of Geneva)		
11.30	Animesh Datta (University of Warwick) *Fundamental limits of pulsed quantum light spectroscopy*	25 min
11.55	Lucia Caspani (University of Strathclyde) *Quantum-enhanced multiphoton fluorescence microscopy*	25 min
12.20	Alex Belsley (University of Bristol) *Absorption estimation with coherent states in ring resonators outperforms any quantum probe single-pass strategy*	25 min
12.45	Zixin Huang (Macquarie University) *Optical quantum super-resolution imaging and hypothesis testing*	15 min

Session Three: chaired by Alex Clark (University of Bristol)

14.00	Michael Cuthbert (NQCC) *NQCC – Purpose and Progress*	25 min
14.25	J Eli Bourassa & Ilan Tzitrin (Xanadu) *Blueprint for a Scalable Photonic Fault-Tolerant Quantum Computer*	25 min
14.50	Karan Mehta (Cornell University) *Scaling and refining trapped-ion quantum control with integrated optics*	25 min
15.15	Jake Bulmer (University of Bristol) *The boundary for quantum advantage in Gaussian boson sampling*	15 min
15.30	Niels Bultink (Qblox) *Sponsor talk*	10 min

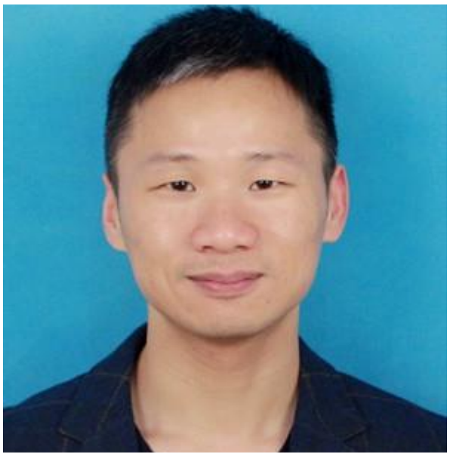
Session Four: Poster session

16.00	Poster session	90 min
18.00	**Drinks reception on board the SS Great Britain (all invited to attend)**	

Welcome drinks at SS Great Britain

Drinks and canapes will be served at our event venue following the poster session at 6pm.

We invite all hybrid workshop registrants to join us for an evening of networking to open our ninth annual workshop.



Sheng-Kai Liao

University of Science and Technology of China

Satellite based Quantum Key Distribution network

Quantum key distribution (QKD) can share random bits between two separated parties called Alice and Bob, Alice uses the bits to encrypt a message with one-time-pad way and deliver it to Bob in a public channel, Bob decrypts it to get the original message, quantum mechanics and Shannon information theory guarantee the security. Since the first protocol was proposed in 1984, lots of experiments have been demonstrated in both fiber channel and free space channel with key rates and distance growing up. With long distance in vacuum, satellite to ground channel has much less attenuation than fiber in the same distance of several hundred kilometers, satellite-based QKD becomes the most feasible way to construct the global QKD network. In this talk, we will present the demonstration and results of satellite-to-ground QKD experiment and QKD network, and the outlook of the next generation of satellite-based QKD.

Anna Pappa

TU Berlin

Anonymity in Quantum Conference Key Agreement

Conference Key Agreement (CKA) is a cryptographic primitive where multiple parties want to establish a secret key. Using multipartite entanglement, we can build protocols for CKA that are both secure and anonymous, i.e. they also hide the identities of the communicating parties.

I will present recent theoretical and experimental results and discuss future directions.

Mariella Minder

University of Oxford

Advances in repeater-like quantum communications

Twin-field (TF) quantum key distribution (QKD) is the only currently implementable protocol able to beat point-to-point QKD and behave similarly to a single repeater system. Exploiting this behaviour, recent experiments have doubled the record distance of QK, harnessing the full potential of TF-QKD by addressing the stringent requirement on phase coherence posed by the protocol. Here, we demonstrate our proposed technique for achieving phase stabilisation, based on the wavelength separation of bright phase reference light and dim signal pulses, robust against previous limitations. This dual-band phase correction scheme allows us to realise a low noise system, able to perform all proposed TF-QKD protocols, with results achieving 605 km, limited solely by the protocol's theory and the usual experimental restrictions, such as detector performance. Finally, we discuss recent development inspired by TF-QKD for the use of coherence for measurement-device-independent (MDI) QKD.

Sophie Hermans

QuTech

Three diamond quantum processors, two entangled links, one multi-node quantum network

A future quantum internet can unlock fundamentally new technologies by sharing entangled states and quantum information across the nodes of the network. In the past decade, many buildings blocks of such a network have been demonstrated. In particular, the heralded distribution of entanglement between two physically separated nodes and quantum teleportation with unit efficiency has been achieved on various platforms, but the next step, experiments using a multi-node quantum network, remained an open challenge.

In this talk I will present our results on the experimental realization of a multi-node quantum network. Our network consists of three nodes, Alice, Bob and Charlie. Each node contains a NV center that acts as a communication qubit to generate remote entanglement with neighboring nodes. Additionally, Bob and Charlie have access to a memory qubit in the form of a carbon-13 nuclear spin. On the network we demonstrate the distribution of a genuine multi-partite entangled state, entanglement swapping[1] and qubit teleportation between non-neighboring nodes[2]. Our work establishes a key platform for exploring, testing and developing multi-node quantum network protocols and a quantum network control stack.

[1] Pompili, M., Hermans, S., Baier, S., et al. (2021). Realization of a multinode quantum network of remote solid-state qubits. Science, 372(6539), 259–264. https://doi.org/10.1126/science.abg1919

[2] Hermans, S., Pompili, M., et al. (2022). Qubit teleportation between non-neighboring nodes in a quantum network, arXiv:2110.11373

Animesh Datta

University of Warwick

Fundamental limits of pulsed quantum light spectroscopy

Quantum light spectroscopy is an emerging field wherein the quantum nature of light is exploited to reveal information about the properties of matter. Although there is evidence that spectroscopy with quantum light may have certain advantages compared to classical spectroscopic methods, this advantage has not been rigorously assessed.

We use quantum estimation theory to identify the ultimate limiting precision of estimating parameters of a matter system when probed by a (travelling) pulse of quantum light. Concretely, we consider the estimation of matter system parameters such as dipole moments and dipole-dipole couplings of individual and pairs of two-level systems respectively. To that end, we compare the performances of different quantum states of quantum light, such as single photons and entangled states of light. We also study the attainability of the quantum limits. These theoretical results should enable the designing of optimal quantum light spectroscopy experiments.

Lucia Caspani

University of Strathclyde

Quantum-enhanced multiphoton fluorescence microscopy

Multiphoton fluorescence microscopy is a widespread imaging technique relying on the excitation of fluorescence (typically in the visible) upon absorption of two or more photons at longer wavelengths. It is the workhorse for deep-tissue imaging, providing optical sectioning up to 0.5-1mm into biological samples. However, to counterbalance the very low cross -section of multiphoton processes, high-intensity pulsed lasers are typically used as illumination source. We are investigating the possibility to exploit the quantum correlations between photons produced in the parametric down conversion process to enhance multiphoton absorption, allowing in principle to achieve higher signal-to-noise ratio and penetration depth than classical systems.

Alex Belsley

University of Bristol

Quantum-limited absorption estimation with ring resonators

Quantum states of light have been shown to enhance precision in absorption estimation over classical strategies. By exploiting interference and resonant enhancement effects, we show that coherent-state probes in all-pass ring resonators can outperform any quantum probe single-pass strategy even when normalized by the mean input photon number. We also find that under optimal conditions coherent-state probes equal the performance of arbitrarily bright squeezed probes in all-pass ring resonators. Our findings are especially relevant for lab-on-chip resonator sensors, which have important practical applications in biochemical analysis and environmental monitoring.

Zixin Huang

Macquarie University

Optical quantum super-resolution imaging and hypothesis testing

Estimating the angular separation between two incoherent thermal sources is a challenging task for direct imaging, especially when it is smaller than or comparable to the Rayleigh length. In addition, the task of discriminating whether there are one or two sources followed by detecting the faint emission of a secondary source in the proximity of a much brighter one is in itself a severe challenge for direct imaging. Here, we experimentally demonstrate two tasks for superresolution imaging based on quantum state discrimination and quantum imaging techniques. We show that one can significantly reduce the probability of error for detecting the presence of a weak secondary source, especially when the two sources have small angular separations. In this work, we reduce the experimental complexity down to a single two-mode interferometer: we show that (1) this simple set-up is sufficient for the state discrimination task, and (2) if the two sources are of equal brightness, then this measurement can super-resolve their angular separation, saturating the quantum Cram\'er-Rao bound. By using a collection baseline of 5.3~mm, we resolve the angular separation of two sources that are placed 15~μm apart at a distance of 1.0~m with an accuracy of 1.7%--this is between 2 to 3 orders of magnitudes more accurate than shot-noise limited direct imaging.

Michael Cuthbert

NQCC

NQCC – Purpose and Progress

With a background in superconductivity and cryogenic systems Michael has had a number of technical and commercial leadership roles with Oxford Instruments in Japan, the US and the UK, most recently as Head of Quantum Technologies. Michael is a member of the Institute of Physics and sits on several advisory panels including the NQTP Strategic Advisory Board.

J Eli Bourassa & Ilan Tzitrin

Xanadu

Blueprint for a Scalable Photonic Fault-Tolerant Quantum Computer

This talk will present Xanadu's proposal for a scalable and fault-tolerant photonic quantum computer. Central to the architecture are Gottesman-Kitaev-Preskill bosonic qubits and squeezed states of light, stitched together into a qubit cluster state with one time and two spatial dimensions. This proposal for generating and manipulating a 3D resource state for fault-tolerant, measurement-based quantum computation combines state-of-the-art proposals for the preparation of bosonic qubits with the strengths of continuous-variable quantum computation performed using easy-to-generate squeezed states. Moreover, the architecture is based on modular, easy-to-network integrated photonic chips, opening the door to scalable fabrication and operation.

Karan Mehta

Cornell University

Scaling and refining trapped-ion quantum control with integrated optics

Practical quantum information processing requires significant advances over current systems in error and robustness of basic operations, and in scale. The fundamental qualities of trapped atomic ion qubits are promising for long-term systems, but the optics required pose a major challenge in scaling. Interfacing low-noise atomic qubits with scalable integrated photonics [1] is a promising route forward, enabling practical extensibility while simultaneously lending robustness to noise in sensitive quantum operations [2]. Furthermore, such techniques allow generation of optical field profiles enabling improvements to coherent and incoherent processes, and as an example I will discuss recent results on ion qubit control in passively phase-stable optical standing waves. Finally, I will touch on possibilities at this interface of photonics and atomic quantum systems to advance future experiments in areas including sensing and precision metrology.

[1] K.K. Mehta, C.D. Bruzewicz, R. McConnell, R.J. Ram, J.M. Sage, and J. Chiaverini. “Integrated optical addressing of an ion qubit.” Nature Nanotechnology 11, 1066-1070 (2016).

[2] K.K. Mehta, C. Zhang, M. Malinowski, T.-L. Nguyen, M. Stadler, and J.P. Home. “Integrated optical multi-ion quantum logic.” Nature 586, 533-537 (2020).

Jake Bulmer

University of Bristol

The boundary for quantum advantage in Gaussian boson sampling

Identifying the boundary beyond which quantum machines provide a computational advantage over their classical counterparts is a crucial step in charting their usefulness. Gaussian boson sampling (GBS), in which photons are measured from a highly entangled Gaussian state, is a leading approach in pursuing quantum advantage. State-of-the-art GBS experiments that run in minutes would require 600 million years to simulate using the best preexisting classical algorithms. Here, we present faster classical GBS simulation methods, including speed and accuracy improvements to the calculation of loop hafnians. We test these on a ~100,000-core supercomputer to emulate GBS experiments with up to 100 modes and up to 92 photons. Our algorithm improves the classical runtime estimates for the latest GBS experiments by a factor of 1 quadrillion (10^15).

DAY TWO AGENDA
WEDNESDAY APRIL 27

TIME	EVENT	LENGTH
Session Five: chaired by Jonte Hance (University of Bristol)		
09.30	Ivette Fuentes (University of Southampton) *Quantum Frequency Interferometry: with applications ranging from gravitational wave detection to dark matter searches*	25 min
09.55	Vlatko Vedral (University of Oxford) *Quantum entanglement induced by gravity*	25 min
10.20	Sabine Hossenfelder (Frankfurt Institute for Advanced Studies) *What is superdeterminism and why should you care?*	25 min
10.45	Mike Paton (Quantum Technologies Innovation Centre) *Sponsor talk*	10 min
Session Six: chaired by Jaya Sagar (University of Bristol)		
11.15	**Equality, diversity and inclusion panel** *How institutions can help fight pandemic burnout and imposter syndrome* Kate Ahl (University of Cambridge) Olya Vvedenskaya (Dragonfly Mental Health) Mehul Malik (Heriot-Watt University)	105 min

Session Seven: chaired by Alex Belsley (University of Bristol)

14.00	Jonte Hance (University of Bristol) *Does the Weak Trace Show the Past of a Quantum Particle?*	15 min
14.15	Tom Bell (University of Bristol) *A framework for loss tolerant graph states from single photon emitters*	25 min
14.40	Ricardo Gutierrez Jauregui (Columbia University) *Unidirectional transport of light along an atomic waveguide*	25 min
15.05	Sophia Economou (Virginia Tech) *Spin-photon interfaces: control and photonic resource state generation*	25 min

Session Eight: chaired by Jorge Monroy Ruz (University of Bristol)

16.00	Dominika Bogusz (Imperial College London) *Nanophotonic devices coupled to molecules for efficient single photon emission*	15 min
16.15	Tobias Kippenberg (EPFL) *Ultra low loss nonlinear Integrated photonics*	25 min
16.40	Sonia Buckley (NIST) *Every photon counts: light sources, detectors and metrology for quantum applications*	25 min
17.05	Marina Radulaski (University of California) *Integrated Color Center Quantum Photonics: from the Clean Room to the NISQ Computers*	25 min
18.00	**Drinks and dinner at Revolucion de Cuba**	

Dinner at Revolucion de Cuba

If you have registered for this year's conference dinner, please make your way to Revolucion de Cuba, Bordeaux Quay, Bristol BS1 5EP

Drinks will be served at 6pm, with dinner at 7pm.

DAY TWO ABSTRACTS

Ivette Fuentes

University of Southampton

Quantum Frequency Interfero metry: with applications ranging from gravitational wave detection to dark matter searches

We introduce a quantum interferometric scheme that uses states that are sharp in frequency and delocalized in position. The states are frequency modes of a quantum field that is trapped at all times in a finite volume potential, such as a small box potential. This allows for significant miniaturization of interferometric devices. Since the modes are in contact at all times, it is possible to estimate physical parameters of global multi-mode channels. As an example, we introduce a three-mode scheme and calculate precision bounds in the estimation of parameters of two -mode Gaussian channels. This scheme can be implemented in several systems, including superconducting circuits, cavity-QED and cold atoms. We consider a concrete implementation using the ground state and two phononic modes of a trapped Bose-Einstein condensate. We apply this to show that frequency interferometry can improve the sensitivity of phononic gravitational waves detectors by several orders of magnitude, even in the case that squeezing is much smaller than assumed previously and that the system suffers from short phononic lifetimes. Other applications range from magnetometry, gravimetry and gradiometry to dark matter/energy searches.

Vlatko Vedral

University of Oxford

Quantum entanglement induced by gravity

In my talk I will discuss a recently proposed witness of quantumness using entanglement. I will comment on the related notions of locality and conservation laws within a fully quantum mechanical formalism. Finally, I intend to elaborate on the feasibility of a table top test of quantum gravity.

Sabine Hossenfelder

Frankfurt Institute for Advanced Studies

What is superdeterminism and why should you care?

The observed violations of Bell's inequality are usually interpreted as showing the local causality is violated. And yet this isn't the whole story. If one instead requires that local causality is respected then one finds that statistical independence must be violated. This is usually referred to as superdeterminism. In this talk I will explain what that means and doesn't mean and what we could learn from taking this option seriously.

Jonte Hance

University of Bristol

Does the Weak Trace Show the Past of a Quantum Particle?

We investigate the weak trace method for determining the path of a quantum particle. Specifically, looking at nested interferometer experiments, when internal interferometers are tuned to destructive interference, we show that the weak trace method gives misleading results. This is as obtaining the weak value of the position operator necessarily perturbs the system, hence the assumption that weak coupling is equivalent to no coupling is incorrect. Further, even if we assume no disturbance, there is no reason to associate the weak value of the spatial projection operator with the classical idea of `particle presence', especially if it has features which go against the classical ideas associated with a particle being present (i.e. a particle having a single, continuous path).

Tom Bell

University of Bristol

A framework for loss tolerant graph states from single photon emitters

We introduce a strategy for the loss tolerant transfer of a qubit down a noisy channel, based on teleportation. This generalizes the “counter-factual” measurement strategies introduced by Varnava et. al., giving us the ability to explore approaches beyond tree-based encodings, and investigate the wider set of graph states. We show how our technique can be extended to large graphs by characterizing the properties of subgraphs in graph states with repeating geometry. In particular, we introduce two methods to construct large graphs, which we call ‘cascading’ and ‘concatenation’. Unitary errors can be mitigated in this scheme by destructive measurements of the flying qubits not involved in the teleportation procedure. We focus on graph states that can be constructed with low resource cost from a constant number of solid state emitters. We finally analyse the performance of some graphs in communication schemes, and show that in the context of one-way quantum repeaters, our approach can outperform previous best strategies.

Ricardo Gutierrez Jauregui

Columbia University

Unidirectional transport of light along an atomic waveguide

Optical isolators that permit transport of light in one direction and block it in the opposite are a subject of considerable interest. Motivated by a recent prediction to engineer the dispersion relation of a waveguide constructed from atomic components, the possibility to create directional transport in an open, collective quantum system can now be explored. In this talk I will review an idealized model for an atomic chain whose optical response is engineered to display directionality. I will discuss a scattering formulation where mode-to-mode transmissions are readily calculated to fully characterize the optical response. Once the conditions for directionality are established, I explore how to retrieve excitations efficiently from a directional chain. To finish, I will include the effect of imperfections that break the periodicity of the array and show that backscattering is suppressed even in the presence of strong noise for a directional chain.

Sophia Economou

Virginia Tech

Spin-photon interfaces: control and photonic resource state generation

Spin-photon interfaces augmented with quantum memories are prime candidates for quantum repeater nodes, the building blocks of the future quantum internet. Some of the challenges in achieving quantum repeaters with such systems include the probabilistic nature of photonic Bell state measurements and the finite coherence time of the quantum memory qubits.

We propose to overcome these challenges through the triggered generation of graph states from quantum emitters based on a general procedure we designed to generate any photonic graph state using minimal resources. The performance-resource tradeoff of repeater graph states generated from emitters is discussed. I will touch upon physical implementations with specific quantum emitters.

Dominika Bogusz

Imperial College London

Nanophotonic devices coupled to molecules for efficient single photon emission

Solid-state photon emitters, like organic dye molecules, can be excellent sources of indistinguishable photons. However, they suffer from low collection efficiency due to the low directionality of the emission. This can be drastically improved through coupling to nanophotonic cavities. Integrated cavities are inherently stable since they are solid-state. An emitter placed at the correct position within such a cavity will preferentially emit photons into a single spatial-spectral-polarisation mode and can also do so at a much faster rate than it would have done outside the cavity. We present nanofabricated optical cavities and our work towards coupling them to molecular photon sources – dibenzoterrylene (DBT) molecules embedded in anthracene (Ac) crystal hosts. These range from devices able to couple the emission to propagating modes in-plane for further processing on the chip such as silicon nitride nanobeam cavities and disk resonators, as well as cavities able to outcouple the photon emission into the far-field ready for fibre coupling, namely circular Bragg grating cavities.

Tobias Kippenberg

EPFL

Ultra low loss nonlinear Integrated photonics

Tobias J. Kippenberg is Full Professor in the Institute of Physics and Electrical Engineering at EPFL in Switzerland since 2013 and joined EPFL in 2008 as Tenure Track Assistant Professor. Prior to EPFL, he was Independent Max Planck Junior Research group leader at the Max Planck Institute of Quantum Optics in Garching, Germany. While at the MPQ he demonstrated radiation pressure cooling of optical micro-resonators, and developed techniques with which mechanical oscillators can be cooled, measured and manipulated in the quantum regime that are now part of the research field of Cavity Quantum Optomechanics. Moreover, his group discovered the generation of optical frequency combs using high Q micro-resonators, a principle known now as micro-combs or Kerr combs. For his early contributions in these two research fields, he has been recipient of the EFTF Award for Young Scientists (2011), The Helmholtz Prize in Metrology (2009), the EPS Fresnel Prize (2009), ICO Award (2014), Swiss Latsis Prize (2015), as well as the Wilhelmy Klung Research Prize in Physics (2015), the 2018 ZEISS Research Award and 2020 OSA R. Wood Award. Moreover, he is 1st prize recipient of the "8th European Union Contest for Young Scientists" in 1996 and is listed in the Highly Cited Researchers List of 1% most cited Physicists in 2014-2019. He is founder of the startup LIGENTEC SA, an integrated photonics foundry.

Sonia Buckley

NIST

Every photon counts: light sources, detectors and metrology for quantum applications

For quantum applications, it is important to generate quantum states of light and detect them with extremely high efficiency. For many future applications, it also important to do this at scale. This presents many engineering and metrology challenges. In the first half of this talk, I will discuss our efforts to develop a scalable silicon-compatible light sources and waveguide-integrated superconducting detectors. In the second half of the talk, I will discuss some of the open challenges and opportunities in metrology of single photon detectors, and our work on developing accurate absolute power calibrations.

Bio: Dr. Sonia Buckley is a physicist at the National Institute of Standards and Technology (NIST) in Boulder, Colorado in the group of Dr. Richard Mirin and Dr. Sae Woo Nam. Sonia received a PhD in Applied Physics and an MS in Electrical Engineering from Stanford University in 2014, and her undergraduate degree in Physics from Trinity College Dublin in 2009. Her doctoral work was done under the supervision of Prof. Jelena Vuckovic on nonlinear frequency conversion in III-V photonic crystal cavities. Her current research interests are in the integration of photonic/opto-electronic devices with superconducting electronics for applications in integrated quantum optics and artificial intelligence.

Marina Radulaski

University of California

Integrated Color Center Quantum Photonics: from the Clean Room to the NISQ Computers

Photonic systems are the leading candidates for deterministic quantum sources, quantum repeaters, and other key devices for quantum information processing. Scalability of this technology depends on the stability, homogeneity and coherence properties of quantum emitters. Here, color centers in wide band gap materials offer favorable properties for applications in quantum memories, single-photon sources, quantum sensors, and spin-photon interfaces. Silicon carbide, in particular, has been an attractive commercial host of color centers featuring fiber-compatible single photon emission, long spin-coherence times and nonlinear optical properties. Integration of color centers with nanophotonic devices has been a challenging task, but significant progress has been made with demonstrations up to 120-fold resonant emission enhancement of emitters embedded in photonic crystal cavities. A novel direction in overcoming the integration challenge has been the development of triangular photonic devices, recently shown to preserve millisecond-scale spin-coherence in silicon carbide defects. Triangular photonics has promising applications in quantum networks, integrated quantum circuits, and quantum simulation. Mapping of this emitter-cavity dynamics to gate-based quantum circuits opens door for quantum advantage in understanding cavity quantum electrodynamical (QED) effects using commercial Noisy Intermediate-Scale Quantum (NISQ) hardware.

EDI PANEL

How institutions can help fight pandemic burnout and imposter syndrome

Kate Ahl

University of Cambridge

Kate is an integrative psychotherapist and former book editor with 20 years' experience working with academics, writers and researchers, most recently as an in-house counsellor for staff and faculty at Cambridge University. In addition to her individual therapy practice, Kate runs a 6-week online programme on Compassionate Productivity for knowledge workers. Her website is kateahlconsulting.com.

Olya Vvedenskaya

Dragonfly Mental Health

Olga was born in Moscow, Russia. She studied medicine specializing in medical biophysics in Moscow and worked on her MD thesis devoted to traumatic brain injury and mass spectrometry at the University of Pittsburgh, USA. She further did her PhD in Berlin, Germany working on multi-omics approach to research of liver cancer and pre-cancerous conditions. She continued her work in translational medicine and mass spectrometry in Dresden, working as a postdoc in MPI-CBG, devoting her spare to academic mental health advocacy. Currently Olga is a Chief Administration Officer at Dragonfly Mental Health, a non-profit working on cultivating excellent mental health in academia.

Mehul Malik

Heriot-Watt University

Mehul is a Professor of Physics at Heriot-Watt University, Edinburgh, where he leads the Beyond Binary Quantum Information Laboratory (BBQ Lab). He currently holds an ERC Starting Grant from the European Commission and a UK EPSRC Early Career Fellowship. His research focuses on the study of structured light in space and time and its application in enhancing quantum technologies for communication, computing, and sensing. Prior to moving to the UK in 2018, Mehul held postdoctoral positions at the University of Vienna and the Institute of Quantum Optics and Quantum Information (IQOQI), Vienna, including a Marie Curie Fellowship in the group of Prof Anton Zeilinger. Mehul's work includes the creation of the first three-particle entanglement in high dimensions, techniques for measuring high-dimensional entanglement with a record efficiency, and the unprecedented transport of entanglement through a complex medium. Mehul was born in New Delhi, India and currently lives in Edinburgh, Scotland with his wife, two children, dog and cat.

DAY THREE AGENDA

THURSDAY APRIL 28

TIME	EVENT	LENGTH
Session Nine: chaired by Michael Steel (Macquarie University)		
09.30	Gerard Milburn (University of Queensland) *Quantum clocks driven by measurement*	25 min
09.55	Chaoyang Lu (USTC) *Photonic quantum computational advantage*	25 min
10.20	Imad Faruque (University of Bristol) *Spontaneous emission tomography*	25 min
10.45	Tiff Brydges (University of Geneva) *Integrated Photonics for Quantum Repeaters*	15 min
11.00	Martin Roetteler (Microsoft) *Sponsor talk*	10 min
Session Ten: Poster session		
11.30	Poster session	90 min

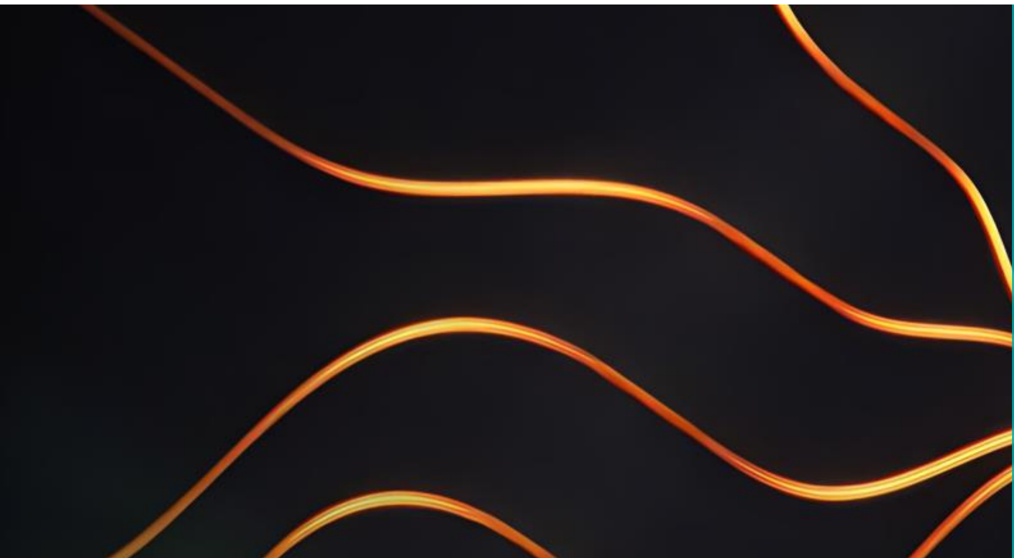
Session Eleven: chaired by Ruth Oulton (University of Bristol)

13.30	James Gates (University of Southampton) *Developing Photonic Components for Quantum Technology Platforms*	25 min
13.55	Lucas Rickert (Technical University Berlin) *A Plug&Play Telecom-Wavelength Single-Photon Source for Quantum Key Distribution*	15 min
14.10	Andrea Blanco Redondo (Nokia Bell Labs) *Topological quantum photonics*	25 min
14:35	Brian Neyenhuis (Quantinuum) *Quantinuum's Commercial Trapped-ion Quantum Computers*	25 min

Session Twelve: chaired by Edmund Harbord (University of Bristol)

15.20	Virginia D'Auria (Université Côte d'Azur) Guided-wave solutions for non-classical states production	25 min
15.45	Sebastian Ecker (IQOQI Vienna) *Experimental Single-Copy Entanglement Distillation*	15 min
16.00	Zheshen Zhang (University of Arizona) *Quantum Information Science and Engineering: Beating the Classical Limits with Entanglement*	25 min
16.25	Michael Holynski (University of Birmingham) *Quantum sensing for gravity cartography*	25 min
16.50	Jonathan Matthews (University of Bristol) *Workshop close*	10 min

17.00 WORKSHOP CLOSE



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SPRING 2023

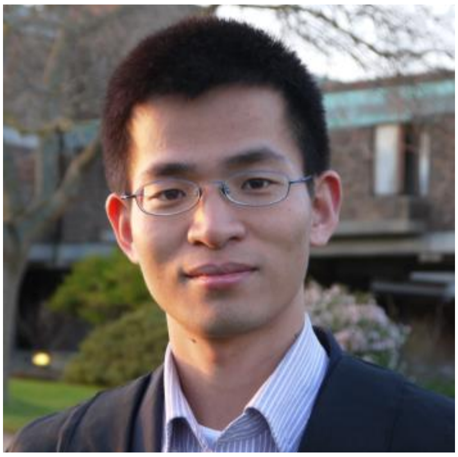
DAY THREE ABSTRACTS

Gerard Milburn

University of Queensland

Quantum clocks driven by measurement

In classical physics, clocks are open dissipative systems driven from thermal equilibrium and necessarily subject to thermal noise. I will discuss quantum clocks, at near zero temperature, driven in part by entropy reduction through continuous measurement and driven by back-action noise. There are two cases: periodic clocks on a limit cycle and non periodic clocks based on quantum jumps in the strong measurement regime. Both regimes constitute a clock, whose signal can be extracted from the observed measurement current and analysed to determine the relation between clock period noise and dissipated power. This demonstrates a fundamental principle: good clocks require high rates of energy dissipation. I will also illustrate this principle in our recent experiment using a superconducting transmon qubit dispersively coupled to an open co-planar resonator.



Chaoyang Lu

University of Science and Technology of China

Photonic quantum computational advantage

We pushed the parametric down -conversion to its physical limit and produce two-photon source with simultaneously a collection efficiency of 97% and an indistinguishability of 96% between independent photons. Using a single quantum dot in microcavities, we produced on-demand single photons with high purity (>99%), near-unity indistinguishability, and high extraction efficiency—all combined in a single device compatibly and simultaneously. We implemented boson sampling with up to 113 photon clicks after a 144-mode interferometer. The photonic quantum computer, Jiuzhang, yields an output state space dimension of 10^43 and a sampling rate much faster using the state-of-the-art simulation strategy on supercomputers.

Imad Faruque

University of Bristol

Spontaneous emission tomography

Quantum photonic entanglement generated from a photon-pair source is a crucial resource for many quantum technological implementations. For example, an entanglement based global quantum network may require photon-pair sources to generate entangled quantum states. Similarly, entangled quantum states from photon-pair sources help enhance metrology beyond classical limits. Here, we demonstrate a process that we call spontaneous emission tomography - SpET, which can be used to reconstruct the full biphoton wave function--both amplitude and phase--of a photon-pair source. This, therefore, enables a full characterization of the entanglement of a photon-pair source. This is the first time such a characterisation has been done without relying on the analytical model of the source. Thus it can be used to characterise particularly the photon-pair sources without any existing models. Furthermore, we have shown that for a resonant source the spontaneous (quantum) process is distinct and cannot be imitated by a stimulated (classical) process.

Tiff Brydges

University of Geneva

Integrated Photonics for Quantum Repeaters

A key component of quantum communication is the distribution of entanglement through networks. However, this comes with several challenges, in particular the limitation of transmission distance from loss through fibres. A solution to this is to distribute information between two nodes in a quantum repeater architecture. Current implementations of quantum repeater protocols involve the use of large, bulk optic photon sources which are impractical when moving towards a realistically implementable and scalable quantum network. Integrated photonics is a promising solution to this problem, allowing large numbers of components to be packaged together in a compact and stable manner. In particular, integrated micro-ring resonators (MRRs) have recently demonstrated excellent performance as photon sources. They are compact, highly stable, and their heralding efficiencies have been shown to be comparable to some narrow-band bulk optic sources; a crucial characteristic for scaling quantum communication to large numbers of photons This poster will present just some of the capabilities of our integrated silicon nitride MRRs, and the applications they have to future quantum networks. It will present key results from successful entanglement swapping experiments between independent integrated MRRs, a crucial step in the distribution of entanglement in quantum networks. In order to subsequently implement a quantum repeater architecture, we are looking to interface our MRRs with quantum memories, in particular, rare-earth ion schemes. These memories have already demonstrated the capacity for long storage time with high multimode capacity and bandwidth. As such, this poster will also present some of the challenges faced in implementing this scheme, and the current work being undertaken in order to overcome them. This includes the ability for electronic frequency tuning of the generated photons, allowing for precise and stable frequency matching of the photons to the quantum memory.

James Gates

University of Southampton

Developing Photonic Components for Quantum Technology Platforms

Photonics is a major enabling technology across the application areas of quantum technology, from single-photon optical networks for quantum comms to high power control lasers in atom and ion traps. This talk will overview some of the current work carried out in Southampton in this area on both academic and industrial projects. Topics will include integrated holographic components for photonic delivery to atom chips, ultra-precision machining of vacuum systems, and parametric generation modules for atom trap control and single-photon sources. The talk will also provide a glimpse into the commercialisation and field deployment of some of these components.

Lucas Rickert

Technical University Berlin

A Plug&Play Telecom-Wavelength Single-Photon Source for Quantum Key Distribution

Quantum light sources are key building blocks for advanced photonic quantum technologies and quantum communication in particular. Among the available solid-state based quantum emitters, semiconductor quantum dots (QD) stand out, as they allow to simultaneously achieve high single-photon purities, in terms of g(2)(0), and high photon indistinguishabilities of single - and entangled-photon states both at large photon collection efficiencies. Additionally, their relatively short radiative lifetime enables high clock rates, as demonstrated in first proof-of-concept QKD experiments using QD single-photon sources (SPSs) under pulsed optical and electrical pumping. A drawback of almost all QD-based SPSs, however, was the need for bulky cryotechnology often requiring liquid helium infrastructure. To resolve this, an innovative concept combining directly fiber-pigtailed deterministically fabricated QD-devices with compact Stirling cryocoolers was recently introduced. In this contribution, we present QKD tests using a 19-inch benchtop single-photon source at 1321 nm based on a fiber-pigtailed quantum dot (QD) integrated into a Stirling cryocooler. Emulating the polarization-encoded BB84 protocol, we achieve an antibunching of g(2)(0) = 0.10 ± 0.01, a raw key rate of up to (4.72 ± 0.13) kHz, and a maximum tolerable loss of 23.19 dB exploiting optimized temporal filters in the asymptotic limit. The results are discussed in comparison to previous works on QD-based single photon sources used for QKD experiments, and an outlook with further improvements for compact quantum light sources is provided. Our study represents an important step forward in the development of fiber-based quantum-secured communication networks exploiting sub-Poissonian quantum light sources.

Andrea Blanco Redondo

Nokia Bell Labs

Topological quantum photonics

In this talk, we will cover recent developments in topological quantum photonics. Topological photonics leverages concepts from geometry and topology – the branch of mathematics that deals with global properties that cannot be changed under continuous deformation – to produce electromagnetic modes that propagate with immunity to disorder and imperfections. In the last few years, several experiments have achieved the generation and propagation of quantum states of light in these so-called topological modes, demonstrating enhanced robustness of such inherently fragile quantum states. In this talk we will focus on our recent results in this area including topological protection of spatial entanglement and the demonstration of topology as an additional degree of freedom for entanglement using CMOS-compatible silicon photonics platforms.

Brian Neyenhuis

Quantinuum

Quantinuum's Commercial Trapped-ion Quantum Computers

Noisy Intermediate-Scale Quantum (NISQ) computers are now commercially available for use though cloud access. I will give an overview of Quantinuum's first generation of commercial quantum computers. We realize the quantum charge coupled device (QCCD) architecture first proposed at NIST with a fully reconfigurable chain of trapped atomic-ions on a multi-zone surface electrode trap.

I will present the benchmarking methods used to quantify the performance of our computer, along with results from a handful of quantum algorithms.

I will also present on our first steps out of the NISQ era with a demonstration of real-time fault-tolerant quantum error correction.

Virginia D'Auria

Université Côte d'Azur

Guided-wave solutions for non-classical states production

In the last years, interest has grown towards the realisation of compact, stable and versatile CV experiments compatible with real-world experiments.

Here we demonstrate, for the first time, the feasibility of a full guided-wave approach for both the generation and measurement of Schrödinger kitten-like states at a telecom wavelength.

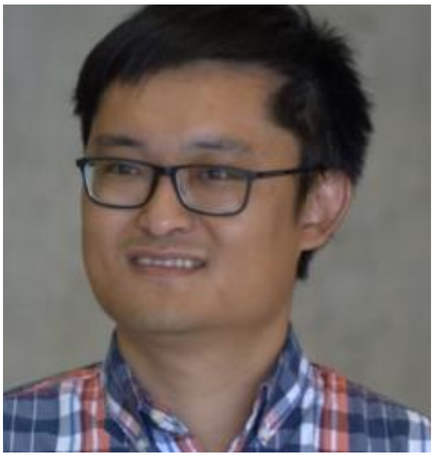
Our setup fully relies on fiber-components and non-linear optical waveguides. This strategy guarantees easy-to-assemble and robust optical realizations and considerably reduce spatial alignment issues. At the same time, it opens to scaled up realisations capable of implementing increasingly complex systems and answering to more and more ambitious objectives.

Sebastian Ecker

IQOQI Vienna

Experimental Single-Copy Entanglement Distillation

Overcoming noise in long-distance entanglement distribution is a key challenge for many quantum technological applications. A promising candidate to this end is entanglement distillation. This involves distribution of two mixed entangled states and concentrating them in a single entangled state with a higher degree of entanglement. While entanglement distillation is well-studied in theory, it lacks the required efficiency in photonic implementations. In our experimental work, we turn around the paradigm of distributing several photon pairs and instead utilize entanglement in multiple degrees of freedom of a single photon pair. Specifically, we make use of the polarization and the energy-time domain of photons, both of which are extensively field tested. We experimentally chart the domain of distillable states and achieve Bell state fidelity gains up to 13.8%. Our approach enables distillation rates which are orders of magnitude higher than in conventional entanglement distillation protocols and therefore pave the way towards high-capacity and noise-resilient quantum networks.



Zheshen Zhang

University of Arizona

Quantum Information Science and Engineering: Beating the Classical Limits with Entanglement

The 20th century has witnessed the rise of quantum mechanics and its fueled scientific and technological revolution. The humankind is now on the verge of a second quantum revolution sparked by quantum information science and engineering (QISE). Entanglement as a quintessential quantum resource lies at the heart of QISE, giving rise to a plethora of quantum -enabled or enhanced capabilities that shift the landscape of communication, sensing, and computing. This talk will present a full-stack QISE approach building on foundational quantum materials, to functional quantum devices, and finally toward system-level entanglement-based applications. I will describe our recent experimental advances in entanglement-based QISE, including quantum machine learning for data classification, entangled sensor networks for precise radiofrequency and optomechanical sensing, and entanglement-assisted communication surpassing the ultimate classical capacity. Next, I will introduce two major endeavors to foster the transition from basic quantum research to near-term, widely impactful real-world quantum technologies: the development of scalable quantum photonics materials and devices and the construction of the Interdisciplinary Quantum Information Research and Engineering (INQUIRE) testbed, a distributed infrastructure to advance convergent QISE research and education.

Michael Holynski

University of Birmingham

Quantum sensing for gravity cartography

In 1500, Leonardo Da Vinci stated that we know more about the stars above us than the ground beneath our feet. That is as true today as it was then. However, the world beneath our feet contains secrets about our history and provides a home for much of our critical infrastructure and resources. It also can contain hazards such as sinkholes and subsidence, and the need to perform maintenance on underground infrastructure leads to major challenges in productivity. Current technologies are limited in how well they can see through the ground, making these interventions difficult to perform. Gravity sensing offers an exceptional advantage in inspecting the underworld, through not being attenuated by the intervening media. However, gravity sensors are limited by vibrational noise – requiring long measurement times that result in such surveys being too costly for wide spread use in the majority of survey applications.

In this talk, I will discuss our realisation of a practical hourglass quantum gravity gradiometer, and discuss this being used for the first demonstrations of quantum gravity sensors detecting targets that are hidden underground. The sensor overcomes a series of environmental challenges and represents a significant improvement in the robustness of quantum sensors. Through removing vibrational noise, this has the potential to open a new regime in practical gravity cartography, being relevant to applications such as across geophysics, climate sciences and alternative navigation.

I will also mention some of the latest activities in translating quantum sensing to applications, and endeavours to apply quantum sensing technologies to some of the open questions in fundamental physics.

POSTER SESSION

1. Euan Allen
University of Bath
Large-scale arrays of integrated homodyne detectors

2. Hiroo Azuma
National Institute of Informatics
Generation of entanglement for two trapped ions in thermal motion with an extended Jonathan-Plenio-Knight method

3. Martin Bielak
Palacky University Olomouc
Multi-projector tomography towards the minimum-error quantum measurement

4. Dominika Bogusz
Imperial College London
Nanophotonic devices coupled to molecules for efficient single photon emission

5. Martin Bohmann
IQOQI Vienna
Entanglement multiplexing through a multicore fiber

6. Šimon Bräuer
Palacky University Olomouc
Cubic squeezing in continuous variables

7. Tiff Brydges
University of Geneva
Integrated Photonics for Quantum Repeaters

8. Jake Bulmer
University of Bristol
The boundary for quantum advantage in Gaussian boson sampling

9. Paul Burdekin
Imperial College London
Atomic Quantum Storage and Telecom Conversion

10. Nicoletta Carabba
University of Luxembourg
Ultimate Speed Limits to the Growth of Operator Complexity

11. Radoica Draškić
Leiden University
Transplanting quantum states

12. Sebastian Ecker
IQOQI Vienna
Experimental Single-Copy Entanglement Distillation

13. Jiří Fadrný
Palacky University Olomouc
Toward faithful transmission of photonic quantum states by heralding on zero photons

14. Anastasios Fasoulakis
University of Bristol
Strain tuning of single photon sources based on dye molecules

15. Suraj Goel
Heriot-Watt University
Designing reconfigurable quantum circuits using complex media

16. Jonte Hance
University of Bristol
Does the Weak Trace Show the Past of a Quantum Particle?

17. Antoine Henry
Télécom Paris
Flexible distribution and quantum state tomography of frequency entangled photon pairs from a 21 GHz SoI frequency comb using frequency quantum gates

18. Natalia Herrera Valencia
Heriot-Watt University
Unscrambling Pixel Entanglement through a Complex Medium

19. Anaelle Hertz
University of Toronto
Nonclassicality gain/loss through photon-addition/subtraction on Multi-Mode Gaussian States

20. Josef Hlousek
Palacky University Olomouc
Photon counting and statistics classification of large optical states with dozens of photons

21. Radim Hošák
Palacký University Olomouc
Entanglement swapping capability of entangled photon pair sources

22. Zixin Huang
Macquarie University
Optical quantum super-resolution imaging and hypothesis testing

23. Alex Jones
University of Bristol
Distinguishability and mixedness in quantum interference

24. Callum Jones
University of Exeter
Photon number variance in single photon emission from hexagonal boron nitride atomic defects

25. Irtaza Khalid
Cardiff University
Statistically characterizing robustness of quantum controllers

26. Kieran Longmate
Lancaster University
Digitisation of Quantum Dot Patterns for Authentication Purpose

27. Gabriel Matos
University of Leeds
Characterization of variational quantum algorithms using free-fermions

28. Daniel Mills
Cambridge Quantum
Volumetric Benchmarking of Digital Error-Mitigation with Qermit

29. Sebastian Philipp Neumann
IQOQI Vienna
Ultra-stable entanglement-based quantum key distribution over a transnational 79 dB fiber link of 248 km length

30. Siyuan Niu
University of Montpellier
Enabling Multi-programming Mechanism for Quantum Computing in the NISQ Era

31. Annie Paine
University of Exeter
Quantum quantile mechanics: Solving SDEs with differentiable quantum circuits

32. Andrew Patterson
University College London
Non-Linearities in Quantum Machine Learning

33. Martin Plávala
Universität Siegen
Operational Theories in Phase Space: Toy Model for the Harmonic Oscillator

34. Lucas Rickert
Technical University Berlin
A Plug&Play Telecom-Wavelength Single-Photon Source for Quantum Key Distribution

35. Nathan Roberts
University of Bath
Topological Photonic Crystal Fibre

36. David Roberts
University of Bristol
Experimental Implementation of Variational Quantum Algorithms on Integrated Photonic Devices

37. Nigam Samantaray
University of Strathclyde
Quantum Lidar with heralded multiplexed photo detection

38. Ross Schofield
Imperial College London
Photon indistinguishability measurements under pulsed and continuous excitation

39. Santiago Sempere-Llagostera
Imperial College London
Experimentally finding dense subgraphs using a time-bin encoded Gaussian boson sampling device

40. Shivanshu Siyanwal
Indian Institute of Science Education and Research Mohali
Machine Learning/Deep Learning -based Entanglement detection and Gate Optimization in NMR Quantum Computation

41. Will Smith
University of Bath
Reducing noise in fibre-based sources of high purity heralded single photons.

42. Naomi Solomons
University of Bristol
Gaussian Boson Sampling and the dense subgraph problem with non-perfect sources and loss

43. Hector Spencer-Wood
University of Glasgow
Measurement disturbance tradeoffs in three-qubit unsupervised quantum classification

44. Vatshal Srivastav
Heriot-Watt University
Noise-Robust and Loss-Tolerant Quantum Steering with Qudits

45. Ivo Straka
Palacky University Olomouc
Anomalous supralinear response of single-photon detectors: avalanche diodes and superconducting nanowires

46. Lara Stroh
Heriot-Watt University
A non-interactive XOR quantum oblivious transfer protocol

47. Vojtech Svarc
Palacky University Olomouc
Sub-0.1 degree phase locking of a wide-band interferometer for single-photon applications

48. Danilo Triggiani
University of Portsmouth
Removing the Network Adaptivity from Distributed Gaussian Quantum Metrology at the Heisenberg Limit

49. Dominik Vašinka
Palacký University Olomouc
Bidirectional optimal quantum control boosted by deep learning: A use case of polarization in liquid crystals

50. Tabijah Wasawo
University of Bath
Towards single-photon switching via two-photon absorption in Rb vapour

51. Jonathan Webb
Heriot-Watt University
Quantum networking advantage with multi-partite entanglement

52. Patrick Yard
University of Bristol
On-chip multi-photon interference with distinguishable photons and time-resolved detection

53. Andreas Fyrillas
Quandela
On-chip device-independent quantum random number generation with a bright and stable single photon source

54. Nico Margaria
Quandela
Efficient, compact and reliable fibred single-photon source

55. Molly Thomas
University of Bristol
Multimode phase stabilisation for distribution of high-dimensional quantum states

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CODE OF CONDUCT

BQIT:22 is a workshop intended for networking and collaboration in the quantum technology community. We value the engagement of each attendee and work to ensure all participants have an enjoyable and fulfilling experience. Accordingly, all attendees are expected to show respect and courtesy to other attendees throughout the workshop and at all workshop events. All attendees, speakers, sponsors and volunteers at BQIT:22 are required to agree with the following code of conduct. Organisers will enforce this code throughout the event. We expect cooperation from all participants to help ensure a safe environment for everybody. Thank you for helping make this a welcoming, friendly event for all.

THE SHORT VERSION

The BQIT team is dedicated to providing a harassment-free conference experience for everyone, regardless of gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion (or lack thereof), or technology choices. We do not tolerate harassment of workshop participants in any form. Sexual language and imagery is not appropriate for any workshop venue or platform, including talks, panels, dinners, Twitter and other online media. Workshop participants violating these rules may be sanctioned or expelled from BQIT:22.

THE LONGER VERSION

Harassment includes, but is not limited to:

- Verbal comments that reinforce social structures of domination related to gender, gender identity and expression, sexual orientation, disability, physical appearance, body size, race, age, religion, or technology choices.
- Sexual images in public spaces.
- Deliberate intimidation, stalking, or following.
- Harassing photography or recording.
- Sustained disruption of talks or other events.
- Unwelcome sexual attention.
- Advocating for, or encouraging, any of the above behaviour.

Participants asked to stop any harassing behaviour are expected to comply immediately. Sponsors are also subject to the anti-harassment policy. In particular, sponsors should not use sexualised images, activities, or other material.

If a participant engages in harassing behaviour, the workshop organisers may take any action they deem appropriate, including warning the offender or expulsion from BQIT:22.

WHO TO CONTACT

If someone makes you or anyone else feel unsafe or unwelcome, please contact our team as soon as possible through our email bqit-admin@bristol.ac.uk. Harassment and other code of conduct violations reduce the value of our event for everyone. We want you to be happy at our event. People like you make our event a better place.

The BQIT team will be happy to help participants contact local law enforcement or otherwise assist those experiencing harassment to feel safe for the duration of the workshop.

We expect participants to follow these rules in all workshop venues, platforms and workshop-related online social events.

ATTENDEE PROCEDURE FOR INCIDENT HANDLING

1. The BQIT team will be prepared to handle the incident. All our staff are informed of the code of conduct policy and guide for handling harassment at the workshop.
2. Report the harassment incident to a BQIT team member either in-person or through email at bqit-admin@bristol.ac.uk (this inbox will be frequently checked for the duration of the event). All reports are confidential. When taking a personal report, our staff will ensure this is confidential. They may involve other event staff to ensure your report is managed properly. During the reporting process, we'll ask you to tell us about what happened. This can be upsetting, but we'll handle it as respectfully as possible. You won't be asked to confront anyone and we won't tell anyone who you are.
3. We will only involve law enforcement or security at a victim's request. If you are not in the UK, please note that you can ask a member of the BQIT team to call the UK authorities on your behalf.

ATTRIBUTION

This Code of Conduct was adapted from confcodeofconduct.com and Geek Feminism Wiki.

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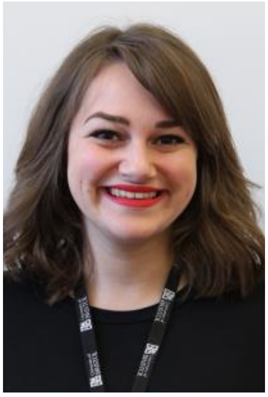

Holly Caskie

BQIT Board Chair, Organisation Lead & QET Labs Research Administrator

Alex Belsley

BQIT poster session team lead and tutorial team advisor, and Quantum Engineering CDT student

Alex Clark

BQIT advertising team lead and programme team advisor, and Senior Lecturer in Electrical & Electronic Engineering

Jonte Hance

BQIT programme team lead and tutorial team advisor, and QET Labs PhD student

Edmund Harbord

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Ruth Oulton

BQIT programme team advisor, and Professor of Quantum Photonics

Giulia Rubino

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External BQIT Board Advisor & Post-Doc at University of Geneva

Eleni Diamanti

External BQIT Board Advisor & Senior Researcher at CNRS

Galan Moody

External BQIT Board Advisor & Assistant Professor at UC Santa Barbara

Michael Steel

External BQIT Board Advisor & Professor at Macquarie University

Sophie Engineer

Advisor to EDI team & Bristol Quantum Engineering CDT student

Jon Pugh

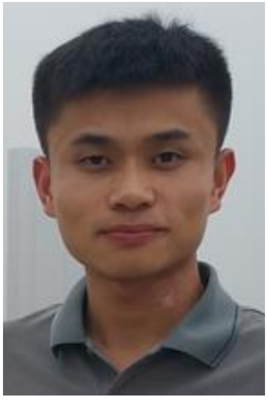
Advisor to Tutorial team & Quantum Engineering CDT Lecturer

Ed Deacon

BQIT helper & QET Labs PhD student

Naomi Solomons

BQIT helper & Quantum Engineering CDT student



Zhi Shi

BQIT helper & QET Labs PhD student

Joel Tasker

BQIT helper & QET Labs Research Associate

THE BQIT TEAM WOULD LIKE TO THANK

Our speakers and panellists for sharing their work and opinions on an expansive range of topics.

Our sponsors for helping to make BQIT a continued success.

The BQIT board members, advisors and helpers for their innovative ideas and diligent work throughout the year. Thank you for your support and enthusiasm during the whole process.

And finally, all of our BQIT:22 attendees for participating. Thank you for joining us, and we look forward to welcoming you back to Bristol soon!

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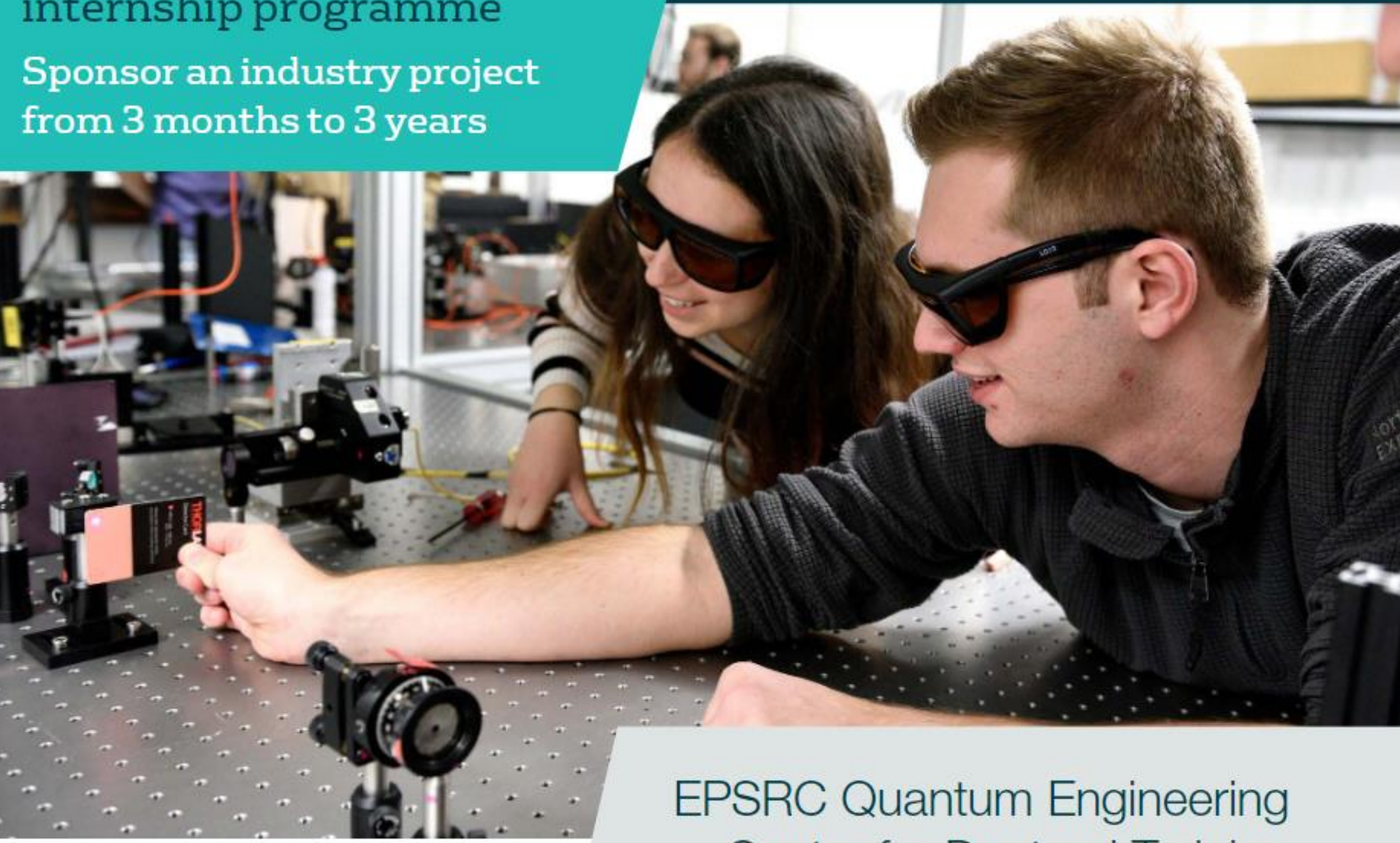

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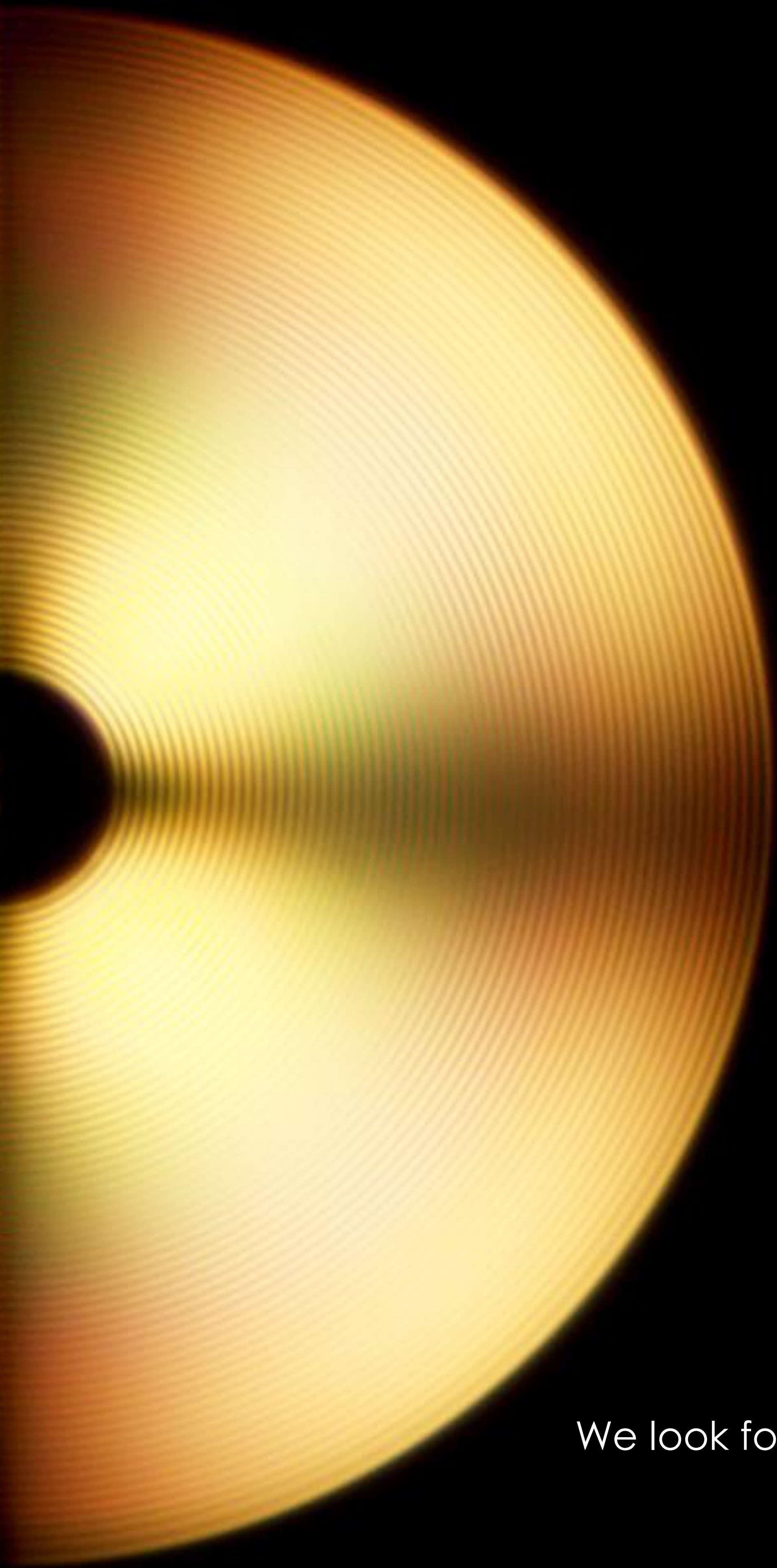

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We look forward to seeing you at:

BQIT:23

SPRING 2023