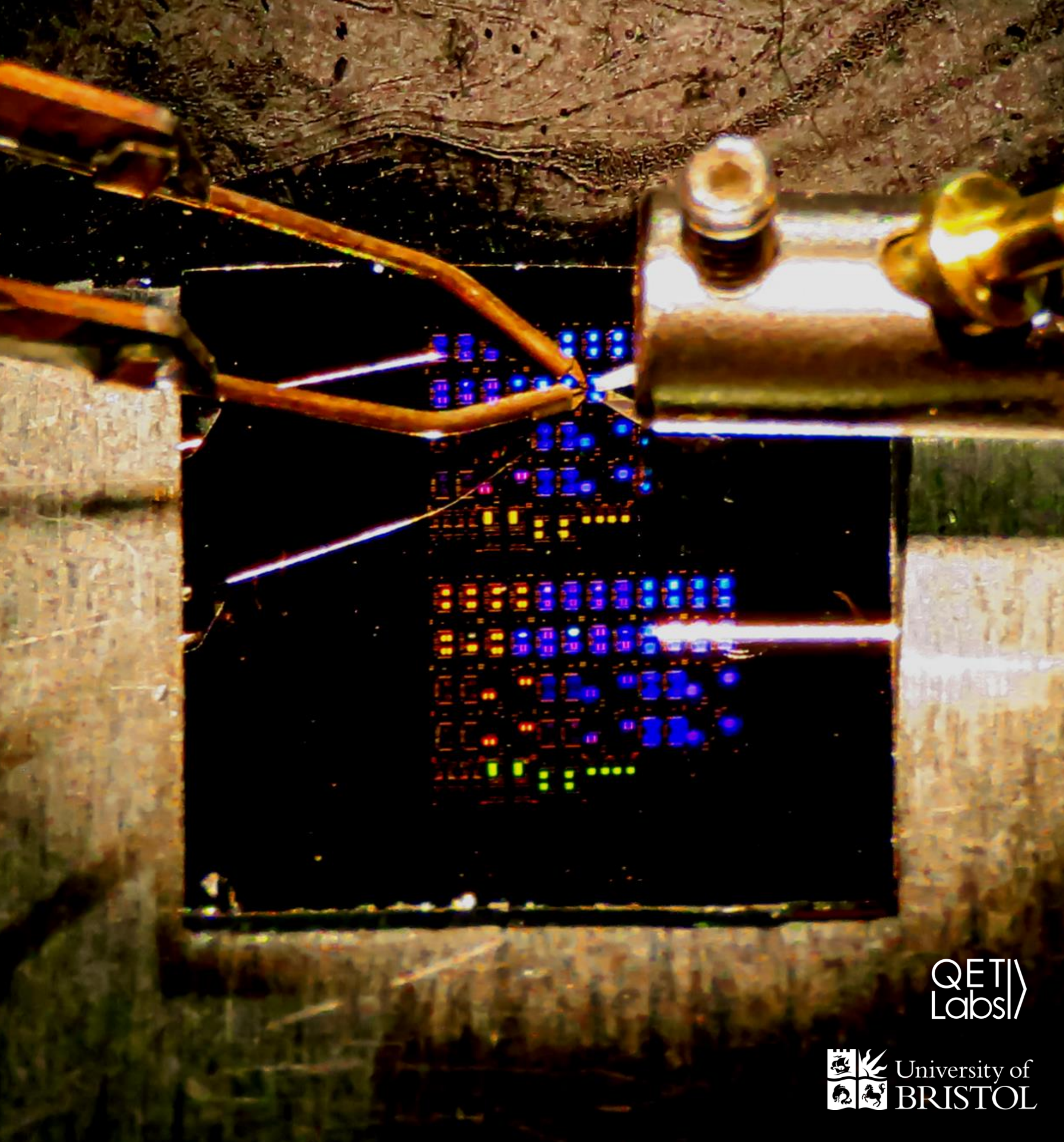
BQIT:23

Tenth Annual Bristol Quantum Information Technologies Workshop

24-27 April 2023



QET Labs

University of BRISTOL

CONTENTS

PROGRAMME COVER IMAGE: SKORYNA-KLINE (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:23 at the discretion of the workshop organisers.

WELCOME TO BQIT:23

Welcome all to BQIT:23, the tenth edition of the Bristol Quantum Information Technologies Workshop. It is an absolute pleasure to have you all here – both in person and online – at what we know will be an exciting few days of stimulating discussions, talks and posters.

Bristol has a rich history in quantum science and technology. In the early 20th century Paul Dirac was studying engineering mathematics here, before going on to carry out his pioneering work in atomic quantum theory and his prediction of antimatter, earning himself a Nobel Prize. Later Lennard-Jones worked here on the early forms of quantum chemistry, while Walter Heitler and Hans Bethe were in Bristol during the mid-20th Century working on quantum electrodynamical forces. Around the same time, Nevill Mott carried out his seminal work on the quantum foundations of the theory of metals and semiconductors, for which he was awarded a Nobel Prize. In the 1950s David Bohm moved to Bristol with his then graduate student Yakir Aharanov, whose names are now combined in every physics textbook describing the interaction of charged particles with electromagnetic fields, the famous Aharanov-Bohm effect. In the 1960s Michael Berry joined the School of Physics here in Bristol, developing the theory behind geometric phases which have become hugely important in quantum processing schemes. At the end of the 20th century, a number of academics were recruited to Bristol in quantum information theory, starting with Sandu Popescu, followed by hires in experimental quantum optics including John Rarity and Jeremy O'Brien. This resulted in the founding of the Centre for Quantum Photonics, which later evolved into the Quantum Engineering Technology Laboratories (QET Labs) – currently home to twelve principal investigators including co-directors Jonathan Matthews and Anthony Laing – which is host to BQIT's past and present.

This long academic history and its culmination in quantum technology development here in Bristol is accompanied by the history we have in running BQIT, now in its tenth year. A precursor to BQIT was the Quantum Photonics Workshop, which was held in the Nanoscience and Quantum Information Building in 2009. This was so successful that we knew we had to continue to provide a platform for world-leading researchers to share their work. With the continued growth of quantum technologies globally, we took the decision to expand the remit to the many technology platforms and applications being pursued, and this tenth edition of BQIT is no different. We have speakers discussing technology platforms ranging from atoms and rare-earth ions through to superconducting qubits and defects in diamond. We have talks and posters spanning the full gamut of quantum applications including communications, sensing, imaging, computing, and tests of fundamental physical phenomena. We are excited to see what new ideas and areas of overlap come from the discussions that BQIT enables.

Over the years we have worked to ensure that BQIT is as inclusive and accessible as possible, and have learnt a lot from taking BQIT virtual in 2020 and 2021, to hybrid in 2022. This year we continue that tradition and bring you a hybrid conference, allowing those that require it the ability to attend online as well as bringing others together in person. We trust that interactions between all attendees, both online and in-person, will be plentiful and fruitful, and that everyone has a thoroughly enjoyable week. We have a number of activities lined up for you all, from drinks receptions and an equality, diversity and inclusion workshop, through to dinner on the SS Great Britain and a panel discussion on the past and upcoming decades of BQIT and associated quantum technology development. We are also extremely grateful and happy to be hosting a large number of industrial sponsors for BQIT this year, and we hope you enjoy interactions with them as well.

With that, the only thing left to say is have a wonderful and productive week, and enjoy all that BQIT and Bristol have to offer. We look forward to meeting you all and enjoying the tenth anniversary of BQIT together.

Holly Caskie, Alex Clark, Anthony Laing and Jonathan Matthews, on behalf of the BQIT board

VENUE & PARKING

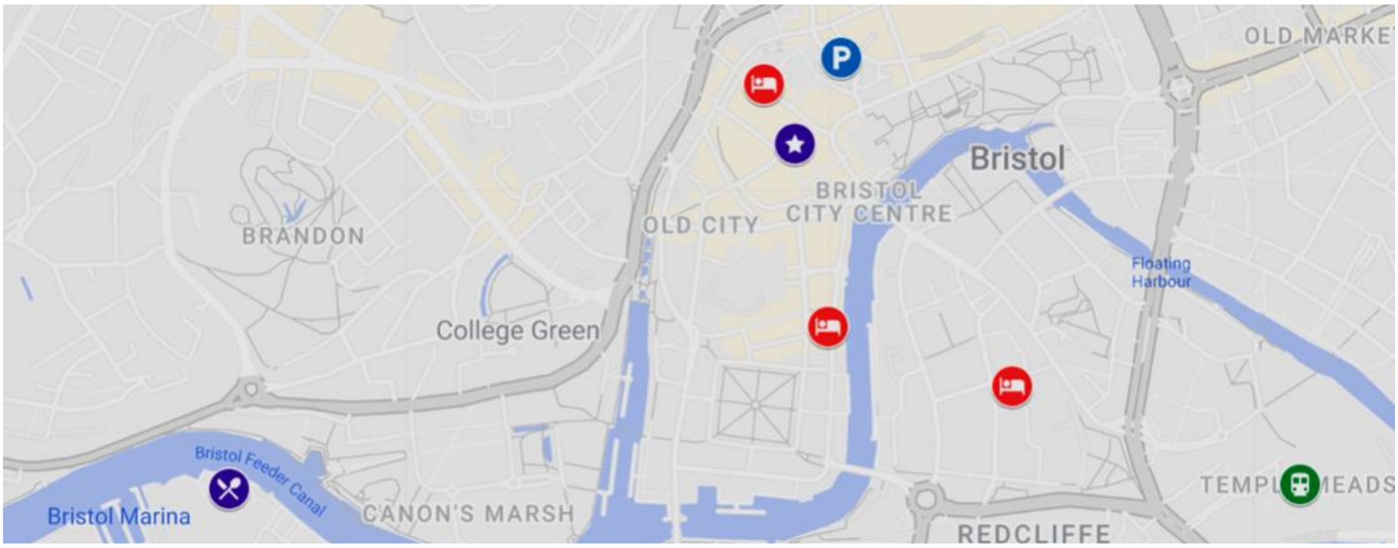
Bristol Harbour Hotel

53-55 Corn St, Bristol BS1 1HT

The in-person component of BQIT:23 will be held in the Bristol Harbour Hotel.

Parking is available at the nearby NCP with a 20% discount.

Drinks will be served at our event venue following the poster session on the first day of our workshop (Tuesday 25 April) at 5pm. We invite all hybrid workshop registrants to join us for an evening of networking to celebrate the opening our tenth annual workshop.



WORKSHOP DINNER

SS Great Britain

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

If you have registered for this year's conference dinner, we invite you to join us at the SS Great Britain following Day Two of our workshop (Wednesday 26 April). Drinks will be served at 6pm, with dinner at 7pm.

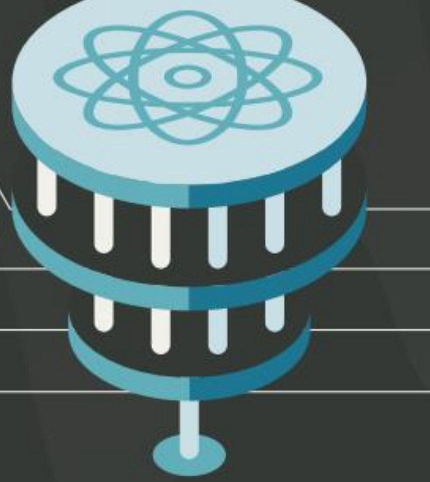
The SS Great Britain can be found along the harbour, a short 15/20 minute walk (or ferry ride!) away.

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.

The Quantum Revolution is Here

Commercial Markets that are Ready

Developments in Quantum technology have become a catalyst for positive change across many industries. Here are a few examples:



INFORMATION SECURITY

Malware, denial of service attacks and other threats are becoming more sophisticated by the day. Quantum research could further the protection of critical infrastructure by:

- Developing more sophisticated cryptography.
- Simulating cyberattacks and defense strategies.
- Enabling advanced testing to ensure the right protection is in place.

HIGH-SPEED COMMUNICATION

Quantum communications has the potential to revolutionize modern industires by providing ultra-secure and high-speed transmission that is immune to hacking and interception. The potential impacts are:

- Enhancing the security and confidentiality of financial transactions.
- Improving the efficiency and accuracy of medical imaging and diagnostic procedures.
- Protecting communication between satellites, aircrafts, and other aerospace applications.

TUTORIAL SESSION
MONDAY
APRIL 24

TIME	EVENT	LENGTH
10.30	Alex Clark (University of Bristol) *Welcome*	10 min
Tutorial One: chaired by Zhi Shi		
10.40	Dominic Sulway (University of Bristol/Light Trace Photonics) *Integrated photonic plumbing*	60 min
11.40	Virtual lab tours	20 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 Sam Mister		
13.00	Tiffany Harte (University of Cambridge) *Quantum sensing with atom interferometry*	60 min
Tutorial Three: chaired by Imad Faruque		
14.15	Vlatko Vedral (University of Oxford) - **presenting online** *Entanglement and indistinguishability*	60 min
15.15	In-person lab tours (limited space) and networking	45 min

16.00 TUTORIAL DAY CLOSE

TUTORIAL ABSTRACTS

Dominic Sulway

University of Bristol/Light Trace Photonics

Integrated photonic plumbing

The University of Bristol's QET Labs specialises in Integrated Quantum Photonics, and so many of the presentations you will see over the course of this workshop will involve integrated photonics in some shape or form. In this tutorial session, we will outline the various theories that underpin classical/quantum integrated photonics, discuss important considerations for developing monolithically integrated quantum photonics systems, explore some popular waveguide material platforms such as Si, SiN and LiNbO3, and work through some useful examples of integrated photonic component design and simulation utilising open-source tools.

Tiffany Harte

University of Cambridge

Quantum sensing with atom interferometry

Cold atom technologies open windows of insight into a range of complex physical phenomena. For example, atom interferometry is a process (analogous to optical interferometry) in which a matter-wave is separated and recombined through interaction with laser pulses, with a readout signal based on the resulting interference pattern: this is sensitive to tiny forces or fluctuations that can affect the matter-wave phase evolution.

In this tutorial I will give an overview of the techniques used in atom interferometry experiments, including methods of cooling and manipulating cold atom clouds, atom-light interactions, and the applications of atom interferometry to a range of quantum sensing applications.

Vlatko Vedral

University of Oxford

Entanglement and indistinguishability

In my tutorial I will discuss entanglement creation and entanglement witnessing by using quantum particles statistics (bosonic and fermionic). A number of basic quantum information protocols, such as quantum teleportation and entanglement swapping could be seen in this light. I will also discuss the notion of fake entanglement as well as the concept of mode entanglement. The latter leads us to the notion of "single particle entanglement" which I plan to talk about in relation to some fundamental questions, such as that of Bell inequality violation as well as the concept of locality.

DAY ONE AGENDA
TUESDAY
APRIL 25

TIME	EVENT	LENGTH
09.20	Alex Clark (University of Bristol) *Welcome and opening of the workshop*	10 min
Session One: chaired by Beth Puzio (University of Bristol)		
09.30	Gavin Morley (University of Warwick) *Nitrogen-vacancy centres in diamond for sensitive magnetometry and (eventually) a test of quantum gravity*	25 min
09.55	Giulia Rubino (University of Bristol) *A new operational approach to measure work in coherent quantum systems*	25 min
10.20	Sarah Malik (UCL) *Quantum computing for particle physics*	25 min
10.45	Sharmilla Balamurugan (University of Warwick) *Signatures of quantum spacetime fluctuations*	15 min
11.00	Yemliha Bilal Kalyoncu (QBlox Quantum) *Sponsor talk*	10 min
Session Two: chaired by Joe Smith (University of Bristol)		
11.30	Helena Knowles (University of Cambridge) *Quantum sensing and quantum simulation using spins in diamond*	25 min
11.55	Anna Kowalczyk (University of Birmingham) *Developing quantum sensors for lifespan brain research*	25 min
12.20	Cristian Bonato (Heriot-Watt University) *Silicon Carbide spin-based quantum devices for quantum networking*	25 min
12.45	Elnaz Darsheshdar (University of Warwick) *Temporal phase modulation of single photons wavepackets for quantum spectroscopy*	15 min

Session Three: chaired by Imad Faruque (University of Bristol)

14.00	Dries Van Thourhout (University of Ghent) *Heterogeneous integration for QPICs*	25 min
14.25	Weiming Yao (Eidenhoven University of Technology) *Bringing photonics and electronics together*	25 min
14.50	Thalia Dominguez Bucio (University of Southampton) *Advanced Silicon Nitride Integration for CMOS Photonic Circuits*	25 min
15.15	Stefan Frick (University of Innsbruck) *Activities on AlGaAs non-linear waveguides at the University of Innsbruck*	15 min
15.30	Mustafa Rampuri and Kimberley Brook (Quantum Frontier) *Sponsor talk*	10 min

Session Four: Poster session

16.00	Poster session	60 min (continues into drinks reception)
17.00	**Drinks reception at the event venue sponsored by Quantum Frontier (all invited to attend)**	

Welcome drinks at Bristol Harbour Hotel

Drinks will be served at our event venue following the poster session at 5pm.

We invite all hybrid workshop registrants to join us for an evening of networking to celebrate our tenth annual workshop and the launch of Quantum Frontier.

DAY ONE ABSTRACTS

Gavin Morley

University of Warwick

Nitrogen-vacancy centres in diamond for sensitive magnetometry and (eventually) a test of quantum gravity

We have built the most sensitive fibre-coupled diamond magnetometer, reaching 30 pT/√Hz in a range from 10-500 Hz. We have shown that this can monitor moving machinery and detect damage in steel.

We also levitate microdiamonds in vacuum towards tests of fundamental physics. For this we will use a nitrogen-vacancy-centre electron spin to put a levitated microdiamond into a quantum superposition of being in two places at once. This would be able to test theories of wavefunction collapse and is the first step of a much more ambitious experiment to test if gravitational effects can be in a quantum superposition. Here we describe our improved experimental design and experimental progress based on magnetic levitation. The nitrogen-vacancy centres in the nanodiamonds we have developed for this have the longest spin coherence times and the longest T1 relaxation times, making them useful for nanoscale quantum sensing.

Giulia Rubino

University of Bristol

A new operational approach to measure work in coherent quantum systems

To capture non-equilibrium dynamics in coherent quantum systems, operational formulations of work beyond 'average work' are needed. Achieving these is a challenging task as they usually require interactions with a measuring device at two different times, potentially altering the state of the system and impacting the final value of work. Moreover, existing no-go theorems have shown that it is impossible to find an operational definition of work for closed quantum systems that both corresponds to the average internal energy difference and recovers classical thermodynamics results for states without quantum coherence. In this talk, I will present a solution to this long-standing problem by showing that a small relaxation of this second requirement allows us to circumvent the no-go theorems by exploiting arbitrarily rare but large fluctuations in the work distribution. I will also demonstrate how this can be implemented in a laboratory setting using an auxiliary system to control work fluctuations, thereby making the protocol deterministic and raising it to a potential contender to standard techniques for characterising work fluctuations in quantum systems.

Sarah Malik

UCL

Quantum computing for particle physics

Quantum computing looks poised to be one of the most transformative technologies of the 21st century, with the potential to play a disruptive role in both science and society. The current intermediate-scale quantum devices provide excellent test beds for performing proof-of-principle studies on using quantum computers to tackle the most challenging problems in particle physics.

The simulation and reconstruction of high energy particle collisions at experiments like the Large Hadron Collider (LHC) relies on modeling the complexity of multi-particle dynamics and efficiently reconstructing them in a densely populated detector environment. I will discuss the current state-of-the-art quantum algorithms that leverage the unique capabilities of quantum devices to simulate, reconstruct and classify collision events at the LHC.

Sharmilla Balamurugan

University of Warwick

Signatures of quantum spacetime fluctuations

Investigations on the quantum nature of gravity may significantly benefit from identifying observable signatures of quantum fluctuations of spacetime. Experimental set-ups such as the Fermilab Holometer attempt to find such signatures using highly sensitive Michelson interferometers. A typical phenomenological model used in this investigation constrains the minimum variance in the strain of the interferometer arm to an arbitrary power of the ratio of Planck length to the interferometer arm length [J. Ng and E. S. Perlman, arXiv:2205.12852 (2022)]. Instead, we propose that the spacetime fluctuations can be effectively modelled as random fluctuations of the refractive index of the medium in the interferometer. We study the effect of such fluctuations on the intensity of the light measured at the detector port. This yields a constraint on the product of the strength and the correlation length of these fluctuations. Further investigations based on our model can be employed to study a variety of experimental setups seeking to detect quantum fluctuations of spacetime.

Helena Knowles

University of Cambridge

Quantum sensing and quantum simulation using spins in diamond

Nanoscale quantum probes based on optically active spins in diamond are a versatile platform for studying solid-state and living systems in a non-invasive way. These sensors can be brought into proximity of a sample of interest and can thus enable in situ few-molecule NMR, nano-thermometry, and imaging of electronic spin textures in exotic materials. Exploiting the high degree of control achieved in diamond spin ensembles through Hamiltonian engineering techniques also allows their use as a solid-state quantum simulator. Such a platform could be used for investigating out-of-equilibrium dynamics and thermalisation of many-body quantum systems. In this talk, I will present several opportunities for nanoscale quantum sensing and quantum simulation using nitrogen-vacancy centers in diamond.

Anna Kowalczyk

University of Birmingham

Developing quantum sensors for lifespan brain research

Optically Pumped Magnetometers (OPMs) have been hailed as the future of human magnetoencephalography (MEG), as they enable a level of flexibility and adaptability that cannot be obtained with conventional MEG systems based on superconductivity. Sensors can be placed closer to the scalp allowing more accurate brain activity source localisation and enabling completely new paradigms to study. While OPM sensors are already commercially available, there is plenty of room for further improvements and customization. Our goal is to develop more resilient OPM sensors that are based on the nonlinear magneto-optical rotation (NMOR) technique and to combine them with other neuroimaging modalities. I will present our modular NOPM sensor that was able to detect auditory evoked fields in a background field of 70 nT and I will discuss the current progress on our sensor development. I will also introduce a model that allows to optimize the dimensions of the sensing volume of an OPM sensor for MEG applications.

Cristian Bonato

Heriot-Watt University

Silicon Carbide spin-based quantum devices for quantum networking

Single optically-active spin defects and impurities have been used in many of the leading implementations of quantum networking. Most world-leading experiments, such as the first loophole-free Bell test and the first demonstration of teleportation in a three-node network have been implemented using the NV centre in diamond. Diamond has, however, several drawbacks in terms of cost, commercial availability and lack of established fabrication recipes.

Here I will review our work on investigating novel spin-active quantum emitters in silicon carbide. In contrast to diamond, SiC is widely used by the micro-electronics industry, with established recipes for wafer-scale growth, doping and fabrication. I will describe how the silicon vacancy (VSi) in SiC can be a promising alternative to the NV centre in diamond, due to its ultra-stable spin-photon interface and its long spin coherence time. I will present our latest result on integration with microelectronic components to deterministically prepare VSi in the spin S=3/2 charge state, and to integrate it in photonic structures. Finally, I will discuss our latest result on a novel spin-active colour centre (based on vanadium impurities) which exhibits direct emission in the telecom O-band with ultranarrow (sub-GHz) inhomogeneous distribution of the spin-photon interface frequencies.

Elnaz Darsheshdar

University of Warwick

Temporal phase modulation of single photons wavepackets for quantum spectroscopy

There are various approaches using dissipative medium in order to perform transformations on temporal modes of the electromagnetic field in the optical regime [1]. This is achievable with the application of time- and frequency-dependent phases and can be applied on pulses of quantum light as well [2]. We study the estimation of the interaction strength between a single-photon pulse and a two-level atom, using the quantum pulse as a probe, i.e., a spectroscopy setting in which only the field can be measured.

As already studied in absence of time-dependent phases [3], there are two sources of information about the parameter: the photon absorption by the atom which can be measured in absorption spectroscopy, and the perturbation to the field temporal mode due to spontaneous emissions. We show that in the presence of a collective environment subsystem coupled to the atom, a quadratic phase modulation on a real pulse retains more information from the scattered light.

References

[1] V. Torres-Company, J. Lancis, and P. Andres, Progress in Optics 56, 1 (2011).

[2] F. Sośnicki, M. Mikołajczyk, A. Golestani, and M. Karpiński, Applied Physics Letters 116, 234003 (2020)

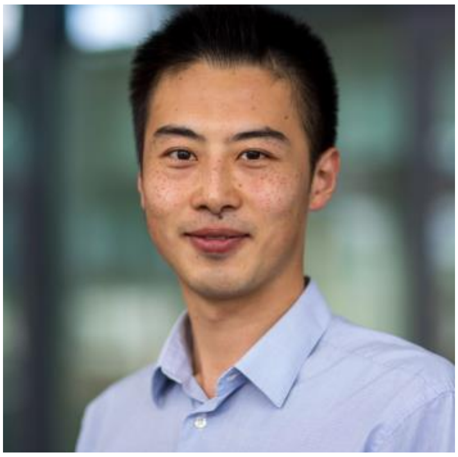
[3] F. Albarelli, E. Bisketzi, A. Khan, and A. Datta, arXiv preprint arXiv:2210.01065 (2022).

Dries Van Thourhout

University of Ghent

Heterogeneous integration for QPICs

Complex Silicon and Silicon Nitride Photonic ICs are widely available now and used in wide range of applications, both classical and non-classical. However, some building blocks are still missing. In this talk, I will discuss how the integration of new materials using micro-transfer printing can overcome this bottleneck. This versatile technique allows to transfer III-V semiconductors, for lasers and single photon sources, ferro-electrics, for modulators and switches but also many other materials.



Weiming Yao

Eidenhoven University of Technology

Bringing photonics and electronics together

Photonic integrated circuit (PIC) technology has matured over the years, making it possible to integrate hundreds of optical components on a chip. Many applications, such as high-capacity transceivers are benefiting from high-density PICs. As operation speed and component density continues to increase, interconnection of photonics with electronics becomes increasingly more important. This talk discusses the need for close co-integration from a telecom and datacom perspective and outlines potential technological solutions including circuit level co-design and wafer-level bonding approaches. Next to traditional telecom and datacom, we discuss how co-integration could benefit PICs for novel emerging applications such as neuromorphic or quantum computing.

Thalia Dominguez Bucio

University of Southampton

Advanced Silicon Nitride Integration for CMOS Photonic Circuits

Silicon photonics has accelerated the deployment of complementary metal-oxide-semiconductor (CMOS) compatible photonic integrated circuits (PICs) based on the silicon-on-insulator (SOI) platform. However, as the technology has evolved, the areas in which the development of PICs is relevant has broadened to applications in which the properties of silicon pose limitations that need to be addressed. As a result, silicon nitride (SiN) platforms with a mid-refractive index (1.7-3.1) have gained interest for the demonstration of PICs. They offer full CMOS compatibility with low propagation losses (<3dB/cm), low thermo-optic coefficient (~10-5 1/K), and negligible two photon absorption (TPA). In this talk, we present our progress in the incorporation of our low temperature SiN platforms for the realisation of linear and nonlinear devices with enhanced functionalities.

Stefan Frick

University of Innsbruck

Activities on AlGaAs non-linear waveguides at the University of Innsbruck

The University of Innsbruck is working on non-linear semiconductor waveguides manufactured in AlGaAs. Besides the good transmission window at telecom wavelengths AlGaAs features an extremely high second -order nonlinearity and is capable of integrated active components such as lasers and optical phase shifters.

These qualities make AlGaAs one of the more interesting semiconductor platforms for integrated (quantum) photonics. Within the last years our work group at the University of Innsbruck was successful at leveraging these properties to design integrated quantum systems.

Recent results include the generation of time-bin entangled photon pairs on a hybrid integrated platform(, photon pair generation on AlGaAs on insulator) and frequency translation of classical light driven by an on-chip laser. Improved fabrication was developed and record low transmission losses are a promising stepping stone for future more demanding quantum applications.

DAY TWO AGENDA
WEDNESDAY APRIL 26

TIME	EVENT	LENGTH
Session Five: chaired by Sam Mister (University of Bristol)		
09.30	Pieter Kok (University of Sheffield) *Large baseline optical imaging assisted by single photons and linear quantum optics*	25 min
09.55	Victoria Wright (ICFO) *An invertible map between Bell non-local and contextuality scenarios*	25 min
10.20	Ivette Fuentes (University of Southampton) *Bose-Einstein condensates for Fundamental Physics*	25 min
10.45	Mark Thompson (PsiQuantum) *Sponsor talk*	25 min
Session Six: chaired by Carrie Weidner (University of Bristol)		
11.30	**Equity, Diversity & Inclusion in Quantum Information Science: Current issues and pathways forward** Co-chaired by Rebecca Gordge (University of Bristol) With talk by: Caroline Clark (Zebera)	90 min

Session Seven: chaired by Ed Deacon (University of Bristol)

14.00	Stasja Stanisic (Phasecraft) *Towards Practical Quantum Advantage*	25 min
14.25	Nicolas Quesada (Polytechnique Montreal) - **presenting online** *Waveguided sources of consistent, single-temporal-mode squeezed light: Applications to Gaussian Boson Sampling*	25 min
14.50	Nikolas Breuckmann (University of Bristol) *Fault-Tolerant Connection of Error-Corrected Qubits with Noisy Links*	25 min
15.15	Ewan Mer (Imperial College London) *A universal programmable Gaussian Boson Sampler for drug discovery*	15 min
15.30	Emlyn Stephens (QuiX) *Sponsor talk*	10 min

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

16.00	Jared Rovny (Princeton University) - **presenting online** *Studying Correlated Dynamics with Two NV Centers*	25 min
16.25	Raghavendra Srinivas (University of Oxford) - **presenting online** *An elementary network of entangled optical atomic clocks*	25 min
16.50	Mark Kasevich (Stanford University) - **presenting online** *Distributed quantum sensing with networks of entangled atomic ensembles*	25 min
17.15	Martin Bielak (Palacký University Olomouc) *The minimum-error quantum-state estimation with multi-projector measurements*	15 min
18.00	**Drinks and dinner at the SS Great Britain**	

Dinner at the SS Great Britain

If you have registered for this year's conference dinner, please make your way to the SS Great Britain, Gas Ferry Rd, Bristol BS1 6TY

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

DAY TWO ABSTRACTS

Pieter Kok

University of Sheffield

Large baseline optical imaging assisted by single photons and linear quantum optics

Combining quantum metrology and networking tools enables the baseline extension of an interferometric optical telescope and thus improves diffraction-limited imaging of point source positions. The quantum interferometer is based on single-photon sources, linear optical circuits, and efficient photon number counters. Surprisingly, with thermal (stellar) sources of low photon number per mode and high transmission losses across the baseline, the detected photon probability distribution still retains a large amount of Fisher information about the source position, allowing for a significant improvement in the resolution of positioning point sources, on the order of 10\;μas. Our proposal can be implemented with current technology. In particular, our proposal does not require experimental optical quantum memories.

Victoria Wright

ICFO

An invertible map between Bell non-local and contextuality scenarios

Bell non-locality and contextuality are two non-classical phenomena that underpin quantum advantage in information processing and computation tasks. We will present a connection between these phenomena via an invertible map between correlations in two party Bell scenarios and correlations in a class of contextuality scenarios. The map takes local, quantum and non-signalling correlations to non-contextual, quantum and contextual behaviours, respectively. Consequently, we find that the membership problem of the set of quantum contextual behaviours is undecidable, the set cannot be fully realised via finite dimensional quantum systems and is not closed. Finally, we show that neither this set nor its closure is the limit of a sequence of computable supersets, due to the result MIP*=RE.

Ivette Fuentes

University of Southampton

Bose-Einstein condensates for Fundamental Physics

The unification of quantum theory and general relativity remains one of the most important open issues in fundamental physics. A main problem is that we are missing experimental input at scales where quantum and relativistic effects coexist. Developing quantum technologies sensitive at these scales might also help answer other big questions, such as the nature of dark energy and dark matter. In this talk I will show how Bose-Einstein condensates (BECs) could be used to search for clues. A single BEC in a superposition of two locations could test if gravity induces the collapse of the wavefunction. Current experiments involve solids such as mirrors and glass nanobeads. In BECs atoms are not bounded as in solids, producing a variety of quantum states that might present advantages. I will also present a proposal to use Bose-Einstein condensates to access new spacetime scales directly. Applications include detecting gravitational waves at high frequencies, miniaturize devices to measure gravitational fields and gradients and set further constrains on dark energy/ matter models.

Caroline Clark

Zebera

ED&I introductory talk

It's exciting to join you in celebrating the 10th anniversary of BQIT and to witness the incredible progress made in quantum technologies since the first conference in 2014. The UK Quantum Technology Programme has made significant investments, leading to groundbreaking research, innovation, and commercialisation, highlighting the immense potential of quantum technologies to transform the world. As a witness to the transformation of people and teams in Bristol, it has been an incredible journey to be a part of.

However, despite the remarkable progress made, there is still untapped potential in the field. The conversation around diversity, equity, and inclusion (DEI) has become more nuanced, and it is an ongoing journey for all of us to understand our role in creating a more diverse, equitable, and inclusive quantum community.

In this session, I will share some of my recent learning experiences and how they have changed my approach to leadership and life.

Stasja Stanisic

Phasecraft

Towards Practical Quantum Advantage

The noisy intermediate-scale quantum era has picked up speed in recent years, with a varied range of companies now offering regular access to devices of diverse qubit numbers, gate errors, and hardware connectivity. The promise of practical quantum advantage is becoming more achievable. This talk will focus on a recent experiment we undertook on the Google Sycamore devices to solve for the ground state of the Fermi-Hubbard model using the variational quantum eigensolver. Putting together such an experiment includes, amongst other tools and techniques, researching the choice of initial states and ansatze to be used, finding suitable fermionic encoding, optimization algorithms, and error mitigation strategies. The talk will cover this experiment against a larger backdrop of Phasecraft's interest into practical quantum advantage and numerous elements of research we have been putting together over the years to make practical quantum advantage a reality.

Nicolas Quesada

Polytechnique Montreal

Waveguided sources of consistent, single-temporal-mode squeezed light: Applications to Gaussian Boson Sampling

We compare the performance of three different types of non-degenerate (twin-beam) squeezed light sources, namely a (i) single-pass non-apodized source where the spatial profile of the nonlinearity is flat, (ii) single-pass apodized source where the nonlinearity has a smooth Gaussian profile in space and (iii) a double pass source with a polarization switch in between. We show that only the third source achieves the desirable property of producing a consistent single temporal mode across different brightnesses. We discuss how not achieving this important criterion negatively affects possible quantum advantage applications via Gaussian Boson Sampling (GBS). We also show they can be used to demonstrate quantum advantage with shallower interferometers using Bipartite GBS. Finally we describe how one can obtain smoothly varying nonlinearity profiles in non-ferroelectric materials for which poling is not possible.

Nikolas Breuckmann

University of Bristol

Fault-Tolerant Connection of Error-Corrected Qubits with Noisy Links

Quantum devices are inherently fragile and scalable quantum computing will require some form of error correction. One of the most promising routes towards scalable quantum computing is a modular approach. We show that distinct surface code patches can be connected in a fault-tolerant manner even in the presence of substantial noise along their connecting interface. We quantify analytically and numerically the combined effect of errors across the interface and bulk. We show that the system can tolerate 14 times higher noise at the interface compared to the bulk, with only a small effect on the code's threshold and sub-threshold behaviour. This implies that fault-tolerant scaling of error-corrected modular devices is within reach using existing technology.

Ewan Mer

Imperial College London

A universal programmable Gaussian Boson Sampler for drug discovery

Gaussian Boson Sampling (GBS) exhibits a unique ability to solve graph problems, such as finding cliques in complex graphs. It is noteworthy that many drug discovery tasks can be viewed as the clique-finding process, making them potentially suitable for quantum computation. However, to perform these tasks in their quantum -enhanced form, a large-scale quantum hardware with universal programmability is essential, which is yet to be achieved even with the most advanced GBS devices. Here, we construct a time-bin encoded GBS photonic quantum processor that is universal, programmable, and software-scalable. Our processor features freely adjustable squeezing parameters and can implement arbitrary unitary operations with a programmable interferometer. Using our processor, we have demonstrated the clique-finding task in a 32-node graph, where we found the maximum weighted clique with approximately twice the probability of success compared to classical sampling. Furthermore, a multifunctional quantum pharmaceutical platform is developed. This GBS processor is successfully used to execute two different drug discovery methods, namely molecular docking and RNA folding prediction. Our work achieves the state-of-the-art in GBS circuitry with its distinctive universal and programmable architecture which advances GBS towards real-world applications.

Jared Rovny

Princeton University

Studying Correlated Dynamics with Two NV Centers

Nitrogen vacancy (NV) centers in diamond are atom-scale defects that can be used to sense magnetic fields with high sensitivity and spatial resolution. Typically, the magnetic field is measured by averaging sequential measurements of single NV centers, or by spatial averaging over ensembles of many NV centers, which provides mean values that contain no nonlocal information about the relationship between two points separated in space or time. I will present our recently demonstrated sensing modality [1] whereby two or more NV centers are measured simultaneously, and we extract temporal and spatial correlations in their signals that would otherwise be inaccessible. I will describe measurements of correlated applied noise using spin-to-charge readout of two NV centers and our implementation of a spectral reconstruction protocol for disentangling local and nonlocal noise sources.

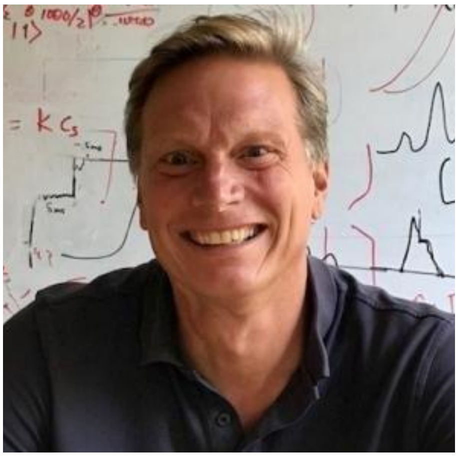
[1] Rovny et al., Science 378, 1301-1305 (2022)

Raghavendra Srinivas

University of Oxford

An elementary network of entangled optical atomic clocks

Optical atomic clocks are our most precise tools to measure time and frequency. Precision frequency comparisons between atoms in separate locations can be used to probe the space-time variation of fundamental constants, the properties of dark matter, and for geodesy. Such frequency comparisons on independent systems are typically limited by the standard quantum limit (SQL). Here, we demonstrate the first quantum network of entangled optical clocks using two ${88}^Sr^+$ ions separated by a macroscopic distance (2 m), that are entangled using a photonic link. We use this network to perform entanglement-enhanced frequency comparisons beyond the SQL[1]. This two-node network could be extended to additional nodes, to other species of trapped particles, or to larger entangled systems via local operations.[1] Nichol, Srinivas et al., Nature 609, 689-694 (2022)



Mark Kasevich

Stanford University

Distributed quantum sensing with networks of entangled atomic ensembles

The noise performance of atomic sensor networks can improve with non-local entanglement protocols. Here we show how a modified quantum non-demolition spin squeezing protocol improves two node atomic clock and atomic interferometer networks. These protocols can be directly applied to recently demonstrated gravity gradient atomic interferometer configurations. Applications of such networks range from satellite geodesy to gravitational wave and ultra-light dark matter detection. We also show how these methods can be extended to larger networks.

Martin Bielak

Palacký University Olomouc

The minimum-error quantum-state estimation with multi-projector measurements

Accurate characterization of quantum states plays a fundamental role in quantum science and technology. The complete characterization of a quantum state requires a tomographic procedure consisting of various measurements performed on a limited number of copies of the state. The choice of individual measurements, preferably local and projective, fundamentally affects the performance of the tomographic scheme. We study the local tomography procedures and investigate their maximum achievable accuracy. We show that overcomplete multi-projector tomography yields a significant reduction in the resulting measurement error despite the decreasing number of detections per projection. We present the detailed numerical simulations and the first experimental demonstration of one- and two-qubit overcomplete tomographic measurements that outperform state-of-the-art approaches such as mutually unbiased bases tomography and minimal information-complete measurements. Notably, for the two -qubit photonic entangled system, we demonstrate a tomographic characterization consisting of 400 local random projective measurements. The experimental multi-projector tomography performs better than the nonlocal mutually unbiased bases tomography and approaches the ideal covariant measurement.

ED&I PARTICIPANT INFORMATION SHEET

ED&I in Quantum Information Science: Current issues and pathways forward

Introduction

In keeping with the theme of "ten years of BQIT", the purpose of this workshop is to explore how ED&I issues in quantum technologies around the world have evolved over the past ten years, to understand what issues we are currently facing, and to gather suggestions for how to move forward and make progress in the next ten years. You have already been asked to make suggestions on topics that should be discussed in a prior survey, and some of these will be included in the discussion portion of the workshop.

Please note that during the discussion portion of the workshop, you will be placed pseudo-randomly in a group of other workshop attendees. That is, we have tried to take steps to ensure that people from the same institution are as separate as possible, and if this is not possible, we have tried to ensure that members of the same research group are not grouped together. If this is not the case (e.g., as PI, if you are grouped with your students or vice-versa), please let one of the organisers know and we will place you in another group. Your group number is located on the reverse of your name badge.

What is ED&I?

ED&I stands for "equity, diversity, and inclusion". Often, this is also written as "equality, diversity, and inclusion". Equity/equality mean that one's identity should be independent of the opportunities available to them. In our context, this ensures that those from disadvantaged backgrounds get the tools they need to access the same opportunities as their peers. "Diversity" is often thought of as highlighting what makes people different, but it really means that instead of putting the spotlight on our differences, we should respect and celebrate what makes us different and what common ground exists across people from different groups. "Inclusion" effectively means that within diverse teams, people from different backgrounds are not segregated off in their own little bubble, nor integrated into the wider team but seen as obvious outliers, but truly included in that they feel a sense of belonging within the group. In practice, what this means is that all members of a team feel that their contributions matter. In the context of this workshop, this means that while a PhD student may have less experience than a postdoc, they should feel that they can freely offer suggestions in this workshop without being made to feel less than or excluded.

Why am I being asked to sign a consent form?

While we are not collecting any research data from this workshop, we are planning to write up the ideas and recommendations that arise and publish them in the June 2023 issue of Physics World. As such, we obtained proper ethical approval for this workshop through the University of Bristol ethics review committee. This ensures that we are taking the right steps to protect both your data and anonymity. In addition, this consent form informs you of your rights to withdraw participation at any time during the workshop. If you wish to take part but do not want your responses recorded by our volunteer scribes, please let us know and we will ensure that this is known by your group's scribe.

Code of conduct

This workshop will discuss a number of topics surrounding equity, diversity, and inclusion issues in quantum technologies. In keeping with the above on what ED&I is, the theme of the workshop is respect. That is, efforts should be taken to ensure that everyone that has something to say is allowed to say their piece, and disagreements should be handled professionally. Many people have strong opinions about the topics that will be discussed today. A healthy debate is encouraged. However, unprofessional behaviour will not be tolerated. Everyone at the workshop is required to abide by the BQIT Code of Conduct outlined on pg. 36/37 of the programme.

DAY THREE AGENDA
THURSDAY
APRIL 27

TIME	EVENT	LENGTH
Session Nine: chaired by Angela Stephen (University of Bristol)		
09.30	Caterina Vigliar (Technical University of Denmark) *High-dimensional optical encodings for integrated error-protected Quantum Computing and Quantum Communication*	25 min
09.55	Raj Patel (Imperial College London) *Gaussian Boson Sampling experiments with displacements and time-bin encoding*	25 min
10.20	Edmund Harbord (University of Bristol) *"More light, more light!" How can we design high brightness, high yield manufacturable sources of single and entangled photons using quantum dots?*	25 min
10.45	Jaya Sagar (University of Bristol) *Compact Quantum Key Distribution module for Nanosatellites*	15 min
11.00	Priya Shinghal (Keysight Technologies) *Sponsor talk*	10 min
Session Ten: Poster session		
11.30	Poster session	60 min (continues into lunch)

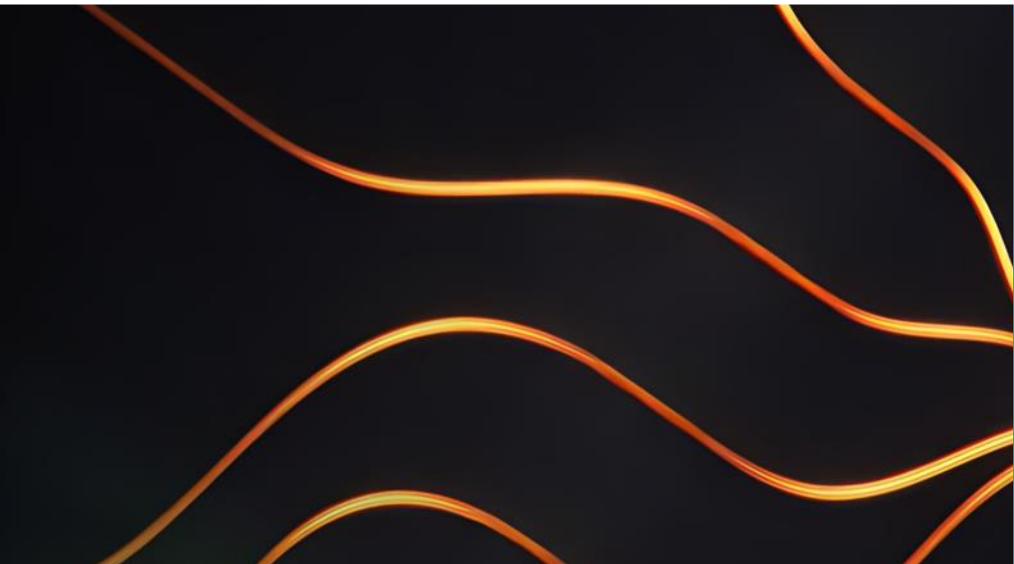
Session Eleven: chaired by Zhi Shi (University of Bristol)

13:30	Frederik Thiele (Paderborn University) *All optical operation of a superconducting photonic interface*	15 min
13.45	Hugues de Riedmatten (ICFO) *Quantum Networking with rare-earth based quantum nodes*	25 min
14:10	Sarah Thomas (Imperial College London) *Deterministic Storage and Retrieval of Telecom Quantum Dot Photons Interfaced with an Atomic Quantum Memory*	25 min
14.35	Amir Safavi-Naeini (Stanford University) - **presenting online** *Quantum MEMS: results, prospects, and challenges*	25 min
15.00	Félix Bussières (IDQuantique) *Sponsor talk*	10 min

Session Twelve: chaired by Joe Smith (University of Bristol)

15.20	**'Ten years of BQIT' panel** Kimberley Brook (University of Bristol) Gavin Morley (Warwick University) John Rarity (University of Bristol) Stasja Stanisic (Phasecraft)	60 min
16.20	ED&I session discussion	10 min
16.30	BQIT representative (University of Bristol) *Workshop close*	10 min

16.40 WORKSHOP CLOSE



We look forward to seeing you at:

BQIT:24

SPRING 2024

DAY THREE ABSTRACTS

Caterina Vigliar

Technical University of Denmark

High-dimensional optical encodings for integrated error-protected Quantum Computing and Quantum Communication

The control of large photonic integrated devices, processing tailored entangled resources of error-protected qubits, is an important step towards realising an all-photonic quantum computer. Measurement-based encodings, computing tasks and applications, showing improvements in such devices´ computational performance, will be shown. Furthermore, future perspectives on the advantages of the distribution of the above resource entangled states over chip-based quantum networks will also be discussed.

Raj Patel

Imperial College London

Gaussian Boson Sampling experiments with displacements and time-bin encoding

Gaussian boson sampling (GBS) is a quantum sampling task in which samples are drawn from the photon-number distribution of a high-dimensional nonclassical squeezed state of light. GBS has garnered much attention, since its proposal, for its ability to perform a task which is intractable with a classical computer. Here, we present our recent experimental progress on GBS.

We report a GBS experiment on a 15-mode silicon integrated photonic circuit where laser light displaces the squeezed state in phase space, which is a key operation that opens new avenues for the utility of GBS. Additionally, we use time-bin interferometers to solve graph problems. Such an apparatus is highly scalable using a fixed number of physical resources. To demonstrate the applicability of this architecture we perform GBS experiments to produce samples to enhance the search of three- and four-node subgraphs in a ten-node graph. We also show how such an apparatus can be adapted to provide full programmability of arbitrary unitary matrices and squeezing parameters to find maximum weighted cliques for molecular docking.

Edmund Harbord

University of Bristol

"More light, more light!" How can we design high brightness, high yield manufacturable sources of single and entangled photons using quantum dots?

Quantum dots (QDs) – nanoscale inclusions of one semiconductor embedded in another – are ideal sources of single and entangled photons, with internal quantum efficiencies of ~100%. They can emit at a range of wavelengths, including in telecommunications bands, and are an underpinning technology in quantum information processing and the nascent quantum internet.

However, the high refractive index of the host matrix inhibits the efficient funnelling of photons into a well-defined optical mode. A widespread solution to this is to use high quality factor micropillars – semiconductor cavities in which the QD-electric field interaction is enhanced, causing photons to be efficient emitted into an optical mode. However, the spectral width of such cavities is narrow (< 0.1nm): combined with the stochastic growth process for self-assembled quantum dots reduces the yield of successful dot cavity devices; moreover, this narrow width precludes the use of exciton-biexciton cascades for efficient photon pair emission.

I will discuss our alternative approach, using low Q factor micropillars, exploiting quantum optics to design cavities that are of comparable efficiencies to high Q devices, while offering broadband emission. This increases the yield of successful QD-cavity devices, and allows efficient extract of photon pairs. I will discuss the progress towards obtaining entangled photon pairs.

Jaya Sagar

University of Bristol

Compact Quantum Key Distribution module for Nanosatellites

Satellite based Quantum Key Distribution (QKD) in Low Earth Orbit is currently the only viable technology to span thousands of kilometres to share quantum information. For the Quantum Communication hub's mission due to be launched within two years, we are designing a dual wavelength, weak-coherent-pulse decoy-state Bennett-Brassard '84 (WCP DS BB84) QKD source. The optical payload is designed in a bespoke aluminium casing to fit within 0.5U (1U = 10cms x 10cms x10cms). The QKD Source module consists of two symmetric sources producing polarization encoded photons, combined and attenuated to a mean photon number of 0.3 and 0.5 photons/pulse. The side channel attacks on the communication link are mitigated by spatially mode filtering the output beam and characterising their spectral and temporal characteristics. The extinction ratio of the source contributes to the intrinsic Qubit Error Rate(QBER) with 0.817±0.001%. This source operates at 200MHz, which is enough to provide secure key rates of a few kilobits per second despite 40 dB of estimated loss in the free space channel.

Frederik Thiele

Paderborn University

All optical operation of a superconducting photonic interface

Advanced electro-optic processing combines electrical control with optical modulation and detection. For quantum photonic applications these processes must be carried out at the single photon level with high efficiency and low noise. Integrated quantum photonics has made great strides achieving single photon manipulation by combining key components on integrated chips which are operated by external driving electronics. Nevertheless, electrical interconnects between driving electronics and the electro-optic components, some of which require cryogenic operating conditions, can introduce parasitic effects. Here we show an all-optical interface which simultaneously delivers the operation power to, and extracts the measurement signal from, an advanced photonic circuit, namely, bias and readout of a superconducting nanowire single photon detector (SNSPD) on a single stage in a 1K cryostat. To do so, we supply all power for the single photon detector, output signal conditioning, and electro-optic readout using optical interconnects alone, thereby fully decoupling the cryogenic circuitry from the external environment. This removes the need to heatsink electrical connections, and potentially offers low-loss, high-bandwidth signal processing. This method opens the possibility to operate other advanced electrically decoupled photonic circuits such as optical control and readout of superconducting circuits, and feedforward for photonic quantum computing.

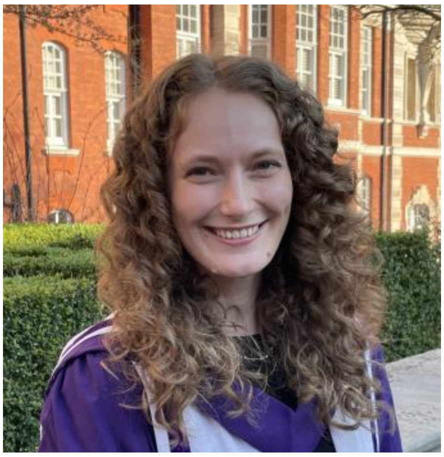
Hugues de Riedmatten

ICFO

Quantum Networking with rare-earth based quantum nodes

The distribution of entanglement between the nodes of a quantum network will allow new advances e.g. in long distance quantum communication, distributed quantum computing and quantum sensing. To distribute quantum entanglement over long distances, quantum repeaters have been proposed. The nodes of a quantum repeater are matter systems that should efficiently interact with quantum light, allow entanglement with photons at telecommunication wavelengths and serve as a quantum memory allowing long-lived and faithful storage of (entangled) quantum bits. In addition, for efficient distribution of entanglement, the nodes should allow multiplexed operation and ideally enable quantum processing capabilities between stored qubits.

In this talk, after introducing the context I will describe our recent progress towards the realization of quantum repeater nodes with multiplexed quantum memories, using cryogenically cooled rare-earth ion doped solids. Recent experiments include a fiber integrated quantum memory and the demonstration of long distance multiplexed quantum teleportation from a photonic telecom qubit to a solid-state collective qubit with active feed-forward. Finally, I will explain our current work to build quantum processing nodes and spin -photon interfaces using single rare-earth ions in nanoparticles embedded in fiber-based microcavities.



Sarah Thomas

Imperial College London

Deterministic Storage and Retrieval of Telecom Quantum Dot Photons Interfaced with an Atomic Quantum Memory

A hybrid interface of solid-state single-photon sources and atomic quantum memories is a long sought-after goal in photonic quantum technologies. The storage and retrieval of single photons on demand is a key requirement for distributing entanglement across a quantum network. Here we demonstrate deterministic storage and retrieval of photons from a semiconductor quantum dot in an atomic ensemble quantum memory at telecommunications wavelengths. We store single photons from a InAs quantum dot in a high-bandwidth rubidium vapour based quantum memory, with a total internal memory efficiency of (12.9 ± 0.4)%. The signal-to-noise ratio of the retrieved photons is 18.2 ± 0.6, limited only by detector dark counts. This represents a significant step towards the goal of an efficient hybrid quantum light-matter interface, key for developing future quantum technologies.

Amir Safavi-Naeini

Stanford University

Quantum MEMS: results, prospects, and challenges

In this talk I will present recent results on quantum control of micro- and nano-eletromechanical devices. We use microwave superconducting circuits to manipulate and characterize their states, and to generate entanglement between separated mechanical objects. Before we can leverage these new degrees of freedom to make useful quantum sensors and computers, we must understand the sources of dissipation that affect them. We use superconducting qubits to identify and probe the primary sources of dissipation, two-level systems (TLS) in these devices, and study how their dynamics are affected.

Kimberley Brook

University of Bristol

'Ten years of BQIT' panel

Kimberley Brook has supported the quantum ecosystem since 2014 when she first joined QET Labs and helped to launch the first BQIT workshop for 85 attendees. Over the few years of organising BQIT, Kim helped to grow it into a conference of 200+ attendees before she left QET Labs in 2016 to support commercialisation of technologies within the University's research and enterprise division. Since then, she has moved into entrepreneurship education initially through the Quantum Technology Enterprise Centre where she helped to create a third of the UK's funded quantum start-ups and now as Director of SETsquared Bristol which is an inclusive technology incubator for high growth businesses.

Kimberley is an avid supporter of taking quantum technologies out of the lab and into the real world and continues to support the creation and development of new quantum entrepreneurs through training initiatives such as her pre-incubation programme QUEST. She is delighted to return to BQIT and see how the event has continued to grow and thrive since the first meeting ten years ago.

Gavin Morley

Warwick University

'Ten years of BQIT' panel

Gavin Morley started his DPhil in 2001 in Oxford with the goal of building a quantum computer using an array of single electron spins. He's still working on this but now with nitrogen-vacancy centres (NVC) in diamond. Since starting his own research group in Warwick in 2011 he has focused on NVC, using them for magnetometry in nanodiamonds and in 1-mm diamonds. His group also levitates single nanodiamonds in vacuum towards getting them into a spatial superposition of being in two places at once. This could lead to a test of the quantum nature of gravity.

He gave an invited talk at the first BQIT meeting in 2014 titled "Quantum Technologies: Review of State-of-the-Art in Hardware (Solid-State)". The meeting was exciting as it was shortly before the first UK Quantum Technology Hubs started.

John Rarity

University of Bristol

'Ten years of BQIT' panel

Prof. John Rarity is a member of Photonics and Quantum Group and QET Labs in the E&EE department here in Bristol and Bristol PI and workpackage leader on the EPSRC quantum technology hubs in Imaging and Communications. He is old enough to remember the conception of quantum technologies (it was an accident, honest), contributing early work on solid-state single-photon detection, quantum interferometry, quantum measurements and quantum key distribution. His present work focusses on quantum technologies: quantum enhanced rangefinding and remote sensing, free space quantum communications to nano-satellites, non-linear interferometry with mid-IR parametric sources and more basic research into counterfactual quantum communication and entanglement schemes.

It was an early Quantum Photonics workshop in 2009 that sparked an appetite for a regular Bristol conference but it wasn't until 2014 that the annual BQIT event was launched. Since then John has been involved as organiser, committee member, speaker, panel member and unofficial after-dinner speaker at various times and venues.

Stasja Stanisic

Phasecraft

'Ten years of BQIT' panel

Stasja Stanisic is currently working as a Senior Quantum Engineer in Phasecraft, trying to make useful and scalable quantum algorithms a reality, through design and implementation of novel algorithms and techniques that allow these algorithms to work on NISQ devices.

Before joining Phasecraft, Stasja was one of the first cohort of Quantum Engineering CDT at the University of Bristol, which began in 2014. Here she researched entanglement and distinguishability of photons.

POSTER SESSION

1. Jeremy Adcock
University of Bristol
A simulation framework for feedforward in quantum photonic systems

2. Cyril Torre
University of Bristol
Precision enhancement in microscopy imaging using a bright Kerr-squeezed state

3. Owain Strassburg
University of Bristol
Non-unitary transform using Linear Optics to realise Variational Quantum Algorithms

4. Alex Belsley
University of Bristol
Quantum-enhanced absorption spectroscopy with bright squeezed frequency combs

5. Yiming Bian (online)
Beijing University of Posts and Telecommunications
A fully integrated and cost-effective vacuum-based quantum random number generator

6. Martin Bielak
Palacký University Olomouc
The minimum-error quantum-state estimation with multi-projector measurements

7. James Blatcher
University of Bristol
Distributed Bragg Reflectors and Resonant Cavities in Photonic Integrated Circuits for Quantum Applications

8. Andriy Boubriak
University of Bristol
Hybrid Integrated Photonic/ Electronic Homodyne Detector for GHz Baud Rate Continuous Variable Quantum Key Distribution.

9. Šimon Bräuer
Palacký University Olomouc
Nonlinear coherent heat machines

10. Tiff Brydges (online)
University of Geneva
Integrated Photonics for Quantum Networks

11. Elena Callus
University of Sheffield
Syndrome extraction using the spin--photon interface

12. Marcus Clark
University of Bristol
Polarisation Based Entanglement Distribution Quantum Networking

13. Sebastian Currie
Quandela
Assessing the quality of near-term photonic quantum devices

14. Elnaz Darsheshdar
University of Warwick
Temporal phase modulation of single photons wavepackets for quantum spectroscopy

15. Debarshi Das
University College London
Mass-independent test of quantumness of a massive object

16. Edward Deacon
University of Bristol
Towards ultra-fast all-optical switching of photons in integrated quantum photonics

17. David Dlaka
University of Bristol
Solid state single photon sources: A cQED roadmap to surpassing 90% efficiency in low Q micropillars

18. Sophie Engineer
Heriot-Watt University
Dimensionality and the Emergence of Objectivity according to the Measurement-Equilibration-Hypothesis

19. Jan Ole Ernst
University of Oxford
Bursts of polarised single photons from atom-cavity sources

20. Giacomo Ferranti
University of Bristol
High-speed homodyne detection in a monolithic ePIC device

21. Imogen Forbes
University of Bristol
Integrated Photonics for Simulating High Energy Physics

22. Stefan Frick
University of Innsbruck
Activities on AlGaAs non-linear waveguides at the University of Innsbruck

23. Samuel Gears
University of Bristol
Scalable frequency multiplexing of single photon sources utilising Bragg-scattering four-wave mixing at 2um wavelengths in silicon

24. Henrik Glavind Clausen
Aalborg University
Measurement-Based Control for Minimizing Energy Functions in Quantum Systems

25. Matt Goh
University of Oxford
Dequantizing quantum neural networks with classically-efficient Lie-algebraic methods

26. Oliver Green
University of Bristol
Integrated Photonics for Generating and Detecting Non-Gaussian States of Light

27. Thomas Hebdige
University of York
Assessment of a quantum random number generator based on photon number statistics

28. Francesco Hoch
Università La Sapienza di Roma
Characterization of multimode linear optical networks

29. Daniel Hodgson
University of Leeds
Local photons and their role in the Casimir effect

30. Meagan Hough
University of Bristol
Reinforcement learning for applications in quantum memories

31. Callum Jones
University of Exeter
Time-dependent Mandel Q parameter analysis for a hexagonal boron nitride single photon source

32. Vojtech Kala
Palacký University Olomouc
Nonlinear squeezing and its decoherence

33. Harry Kendell
University of Bristol
Lattice based control of ultracold atoms

34. Irtaza Khalid
Cardiff University
Sample-efficient Model based reinforcement learning for Quantum Control

35. Zhe Xian Koong
Heriot-Watt University
Single-emitter quantum key distribution over 175 km of fiber with optimised finite key rates

36. Zhenghao Li
Imperial College London
A Complexity Transition in Displaced Gaussian Boson Sampling

37. Aaron Malcolm
University of Warwick
Detecting Signatures of Electromagnetic Vacuum Fluctuations

38. Daniel Marchant
University of Bristol
Generating Quantum States of Light in a hybrid Silicon-BTO Platform

39. Marta Maria Marchese
Universität Siegen
Quantum-enhanced imaging for large baseline optical telescopes

40. Ewan Mer
Imperial College
A universal programmable Gaussian Boson Sampler for drug discovery

41. Michal Neset
Palacký University Olomouc
Generation and characterization of multi-photon added coherent state

42. Yoann Pelet
INPHYNI
Operational real field entangled quantum key distribution over 50km

43. Oliver Powell (online)
University of Cambridge
Optical characteristics of single-defect colour centres in hexagonal boron nitride

44. Jonas Pudelko
Friedrich-Alexander-Universität Erlangen-Nürnberg
Integrated photonics for quantum communications on a CubeSat

45. Dario Antonio Quintero Dominguez
University of Bristol
A Single-Photon Multiplexer System Engineering Toolset

46. Giovanni Rodari
Università La Sapienza di Roma
Experimental nonclassicality in a causal network without assuming freedom of choice

47. Jaya Sagar
University of Bristol
Compact Quantum Key Distribution module for Nanosatellites

48. Shradhanjali Sahu (online)
University of Leeds
Discrete Modulation Continuous Variable Quantum Key Distribution in Multiple-Input Multiple-Output Settings

49. Reece Shaw
University Of Bristol
Errors in heralded circuits for linear optical entanglement generation

50. Patrik Sund
Niels Bohr Institute
Processing single-photons from a quantum dot using high-speed integrated photonic circuits on the thin film lithium-niobate-on-insulator platform

51. Frederik Thiele
Paderborn University
All optical operation of a superconducting photonic interface

52. Danilo Triggiani
University of Portsmouth
Ultimate quantum sensitivity in the estimation of the delay between two interfering photons through frequency-resolving sampling

53. Tess Troisi
INPHYNI
High rate sagnac source for satellite-ground applications

54. Hao-Cheng Weng
University of Bristol
NV centers integrated with foundry silicon nitride chips

55. Patrick Yard
University of Bristol
On-chip quantum information processing with distinguishable photons

56. Jonas Zatsch
University of Stuttgart
Integrated Photonics for Quantum Computing and Communication

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CODE OF CONDUCT

BQIT:23 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:23 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:23.

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:23.

WHO TO CONTACT

If someone makes you or anyone else feel unsafe or unwelcome, please contact our team as soon as possible, either in person or 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.

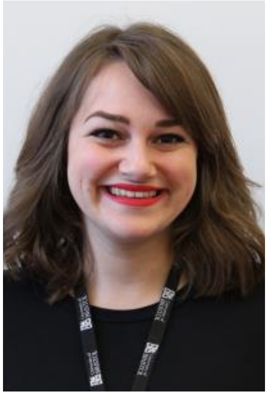
ATTENDEE PROCEDURE FOR INCIDENT HANDLING

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]().

BQIT:23 BOARD



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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:23 attendees for participating. Thank you for joining us, and we look forward to welcoming you back to Bristol soon!

University of BRISTOL

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We look forward to seeing you at:

BQIT:24

SPRING 2024