CONNECT COORDINATE CONTRIBUTE

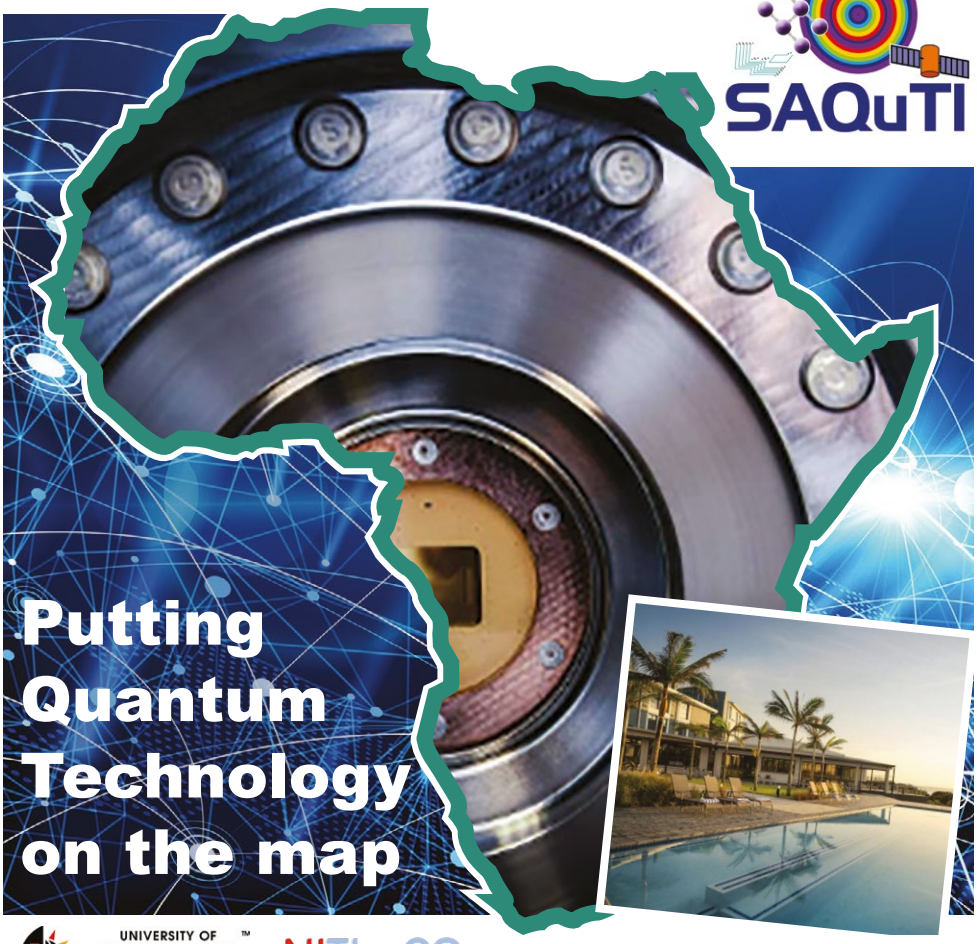
PROGRAMME

South African Quantum Technology Initiative Workshop

8-11 May 2023

Premier Resort Cutty Sark Scottburgh

SAQuTI



UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

NITheCS
National Institute for Theoretical and Computational Sciences

science & innovation
Department:
Science and Innovation
REPUBLIC OF SOUTH AFRICA

Venues FOR CONFERENCES IN AFRICA

PREMIER HOTELS & RESORTS

MONDAY 8th MAY

Overview of the South African Quantum Technology Initiative
Speaker: Prof. A. Forbes, University of the Witwatersrand
Time: 14:00-15:00

Multivalue Logic devices based on Coulomb Blockade and Quantum Tunneling
Speaker: Prof. R. Harris, University of the Free State
Time: 15:30-16:00

Quantum Computing
Speaker: Prof. F. Petruccione, Stellenbosch University and University of KwaZulu-Natal
Time: 16:00-17:00

TUESDAY 9th MAY

Quantum Communication
Speaker: Prof .A. Forbes, University of the Witwatersrand
Time: 9:00 - 10:00

Quantum Metrology
Speaker: Prof. M. Tame, Stellenbosch University
Time: 10:30 - 11 :30

Quantum technology at NMISA: Parametric down-conversion for quantum optical metrology
Speaker: Prof. F. S. Roux, National Metrology Institute of South Africa
Time: 11 :30-12:00

Abstract: The process of parametric down conversion is analysed in full detail incorporating both the particle-number degrees of freedom and the spatiotemporal degrees of freedom. This analysis is facilitated by a Wigner functional formalism. For the purpose of a metrology application, we compute the output photon distribution of the down converted light. It can be measured with a CCD array and used to determine experimental parameters, such as the squeezing parameter.

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Quantum Technology at WITS
Speaker: Prof. A. Forbes, University of the Witwatersrand
Time: 12:00-12:30

Quantum Technology at Stellenbosch University
Speaker: Prof. M. Tame, Stellenbosch University
Time: 14:00-14:30

Quantum Technology research at CPUT
Speaker: Dr K. Govender, Cape Peninsula University of Technology
Time: 14:30-15:00

Quantum Technology at UKZN
Speaker: Prof. T. Konrad, University of KwaZulu-Natal
Time: 15:30-16:00

Quantum Technology at UniZulu
Speaker: Prof. N. Revaprasadu, University of Zululand
Time: 16:00-16:30

WEDNESDAY 10th MAY

Application Areas for Quantum Technology within Hensoldt's Detect and Protect Products and Solutions.
Speaker: Mr. W Ingram, Hensoldt
Time: 9:00-9:30

Abstract: Hensoldt develops and supplies sensors and solutions for air, land and maritime security and defense. These systems include inter alia radar and electro-optic systems, EW spectrum monitoring equipment and airborne data links. The purpose of the presentation is to give an introductory overview ofHensoldt current products and technologies, thereby creating a foundation for discussions on how advances in quantum sensing, computing and communications could support us in fulfilling future customer needs.

How Space Physics in Antarctica unlocks wildfire detection technologies for tracking carbon emissions.
Speaker: Dr G. Hough, EnviroVision Solutions
Time: 9:30-10:00

New Frontier: The convergence of Machine Learning and Quantum Technologies
Speaker: Dr T. Radinne, Raphta
Time: 10:30-11 :00

IBM Quantum
Speaker: Dr G. Dawson, IBM
Time: 11:00-11:30

Benchmarking NISQ-era quantum computers with Shor's algorithm
Speaker: Dr E. Davis, Sol Plaatje University
Time: 11:30-12:00

Abstract: We discuss recent attempts to employ Shor's factoring algorithm in the benchmarking of quantum computers. The focus is on useful properties of the theoretical distribution of outcomes of period register measurements. A simple alternative to the normalized fidelity introduced by the Quantum Economic Development Consortium (QED-C) is suggested.

How Good are the Large Language Models at Explaining Quantum Technology?
Speaker: Dr M. Senekane, University of Johannesburg
Time: 12:00-12:30

A Shift from Classical Optical Commnnication to Qnantum Communication
Speaker: Dr D. Waswa, Nelson Mandela University
Time: 14:00-14:30

Abstract: This presentation explores application for applying existing expertise and the stateof-the-art equipment at NMU in classical optical communication and sensing to the Quantum domain. At the Centre for Broadband Communication (CBC) we carry out projects in high speed data transmission in optical communication

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above 10 G/s for growing cloud services, big data science for the Square Kilometre Array (SKA) and environmental sensing. We have developed systems using 850nm multimode transceiver modules to investigate the lives under sea. We have done multilevel modulations using QAM, PAM and QPSK for intra-centre connectivity above 10Gb / s having all optical wavelength switching using low cost 1550 nm single mode VCSEL and data detected by highly sensitive coherent receivers. Another key highlight is on stable time and frequency reference generation that improved the frequency stability. This has facilitated stable frequency distribution and synchronization for SKA project and has also been proved that the round trip latency achieved meets the threshold for 5G networks. At CBC, we also investigate efficient and accurate ways of sensing the environmental hazard that can endanger the lives of humanity. We are building an optical system that can interrogate civil structures for over 28 km of existing fibre infrastructure.

In all these, the energy consumptions, limited capacity and security of data remains biggest challenge in classical optical communication hence the shift to quantum optical communication.

We are focused on designing and testing of state-of-the-art quantum communication systems in terms of achievable rate, channel distance and interoperability with current classical communication infrastructure that is presently at CBC.

Towards long range free-space optical communications at the Wits OC Lab
Speaker: Dr M. Cox, University of the Witwatersrand
Time: 14:30-15:00

Single Electron Pumping
Speaker: Dr M. Blumenthal, University of Cape Town
Time: 15:30-16:00

Toward the use of deep neural networks in developing a model of single electron transport through a dynamic quantum dot.
Speaker: Dr D. Mahony, University of Cape Town
Time: 16:00-16:30

First Principle analysis of quantum pumping
Speaker: Dr S. Ahmad, University of Cape Town
Time: 16:30-17:00

	8 MAY	9 MAY
9:00-10:00		**Quantum Communication** (A. Forbes, WITS)
10:00-10:30	ARRIVALS	TEA
10:30-11:30		**Quantum Metrology** (M. Tame, SU)
11:30-12:30		**Quantum Technology at NMISA** (S. Roux, NMISA)
		Quantum Technology at WITS (A. Forbes, WITS)
12:30-14:00	LUNCH	LUNCH
14:00-15:00	**Opening and Overview of SA QuTi** (A. Forbes, WITS)	**Quantum Technology at Stellenbosch** (M. Tame, SU)
		Quantum Technology at CPUT (K. Govender, CPUT)
15:00-15:30	TEA	TEA
15:30-16:30	**Multivalue Logic devices using Quantum Tunneling** (R. Harris, UFS)	**Quantum Technology at UKZN** (T. Konrad, UKZN)
	Quantum Computing (F. Petruccione SU & UKZN)	**Quantum Technology at UniZulu** (N. Revaprasadu, UniZulu)
16:30-17:30	**QTI Olympiad**	**QTI Olympiad / SAQuTI Committee meeting**
18:00-20:00	DINNER	DINNER
20:00-21:00		

10 MAY	11 MAY
Industry talks: Application Areas for Quantum Technology within Hensoldt's Detect and Protect Products and Solutions (P. Haupt and W. Ingram, Hensoldt Optotronics)	**An engineer's experience of Quantum Computing** (K. Nixon. WITS)
Industry talks: Wildfire detection technologies for tracking carbon emissions. (G. Hough, EnviroVision Solutions)	**Measuring experimental parameters from SPDC intensity profiles.** (B. Jodaan, NMISA)
TEA	TEA
Industry talks: New Frontier: The convergence of Machine Learning and Quantum Technologies (T. Radinne, Raphta)	**Quantum sensing of emergent many-body phenomena: new insights from the Kondo state** (A. Ukpong, UKZN)
Industry talks: IBM Quantum (G. Dawson, IBM)	**Photosynthesis, quantum sensing and energy applications** (T. Kruger, UP)
Benchmarking NISQ quantum computers (D. Davies, Sol Plaatje University)	**Group Discussion Quantum Metrology / Sensing**
How Good are the Large Language Models at Explaining Quantum Technology? (M. Senekane, UJ)	
LUNCH	LUNCH
A Shift from Classical Optical Communication to Quantum Communication (D. Waswa, NMMU)	**Group Discussion Quantum Communications**
Towards long range free-space optical communication at the Wits lab (M. Cox, WITS)	
TEA	TEA
Single Electron Pumping (M. Blumenthal, UCT)	**Group Discussion Quantum Computing**
Deep neural networks to model single electron transport (D. Mahony, UCT)	
First Principle analysis of quantum pumping (S. Ahmad, UCT)	**Objectives for 2024**
Quantum density matrix formalism for non-Hermitian Hamiltonian systems (K. Zloshchastiev, DUT)	
DINNER	DINNER
Public Talk - Quantum Information Technology in South Africa (S. Roux (NMISA)	**Quantum Technology meets Jazz** (Andile Yenana)

Quantum density matrix formalism for non-Hermitian Hamiltonian systems
Speaker: Dr K. Zloshchastiev, Durban University of Technology
Time: 17:00-17:30

Public talk: Quantum Information Technology in South Africa
Speaker: Prof. F. S. Roux, NMISA
Time: 20:00-21:00

Abstract: Recently, the Department of Science and Innovation (DSI) launched the South African Quantum Technology Initiative (SAQuTI). This initiative is briefly presented, mentioning some of the activities in quantum information technology in South Africa that it supports. An overview of what quantum information technology involves and where it came about is also provided.

THURSDAY 11th MAY

An engineer's experience of quantum computing.
Speaker: Prof. K. Nixon, University of the Witwatersrand
Time: 9:00-9:30

Measuring experimental parameters from SPDC intensity profiles.
Speaker: Dr B. Jordaan, NMISA
Time: 9:30-10:00

Quantum sensing of emergent many-body phenomena: new insights from the Kondo state
Speaker: Dr A. Ukpong, University of KwaZulu-Natal
Time: 10:30-11 :00

Photosynthetic light-harvesting complexes: inspiring quantum systems for sensing and solar energy applications.
Speaker: Dr T. Kruger, University of Pretoria
Time: 11 :00-11 :30

Abstract: Most light-harvesting complexes of photosynthetic organisms are characterised by a remarkably high density of pigments held in a precise arrangement by one or more proteins. The dense pigment packing gives rise to strong

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excitonic coupling amongst the pigments so that excitations are coherently shared within pigment groups. These quantum superpositions give the organisms various physiological benefits. In addition, the excitons are strongly coupled to a noisy environment, a phonon bath contributed to by the pigments and their surrounding protein environment. The result is a complex dissipative system but with several strong phonon modes used by the organisms to improve the efficiency of excitation energy transport. Even more intriguing is the fact that the light-harvesting complexes are sensors of their microenvironment - in particular, sensors of protons and oxygen. When sensing those particles, the protein changes its structure and switches to a state with a different biological function.

The performance and stability of organic solar cells may benefit from the implementation of selected design principles of photosynthetic light-harvesting complexes. Unlike photosynthetic systems, the pervasive conformational and energetic disorder in polymer films limits their transport properties instead of enhancing them. Quantum coherence may be useful in this context. Specifically, current bulk heterojunction architectures have a high level of structural disorder, giving rise to large interfacial areas where recombination can occur. Instead, the use of a more ordered design would allow better quantum coherence amongst domain molecules, giving rise to larger diffusion lengths and less interfacial recombination.

GROUP DISCUSSIONS: TECHNOLOGY DEVELOPMENT ROADMAP

11:30 - 12:30: Quantum Metrology / Sensing
14:00 - 15:00: Quantum Communications
15:30 - 16:30: Quantum Computing
16:30 - 17:30: Objectives for 2024

Some discussion points: How can you contribute? How does your work slot into the themes? How could you become part of a node or form a new node? Funding? How can we bring people into the programmes? How would you help drive technology development in South Africa? Which concrete industrial projects and partnerships between companies and scientists/engineers in research institutions can we form? Define aims for the near and far future!

LIST OF DELEGATES

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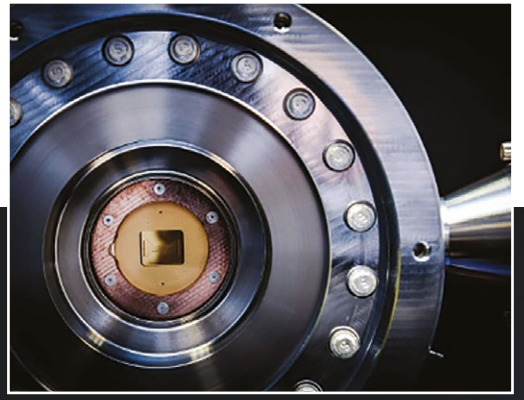
Quantum Information Technology

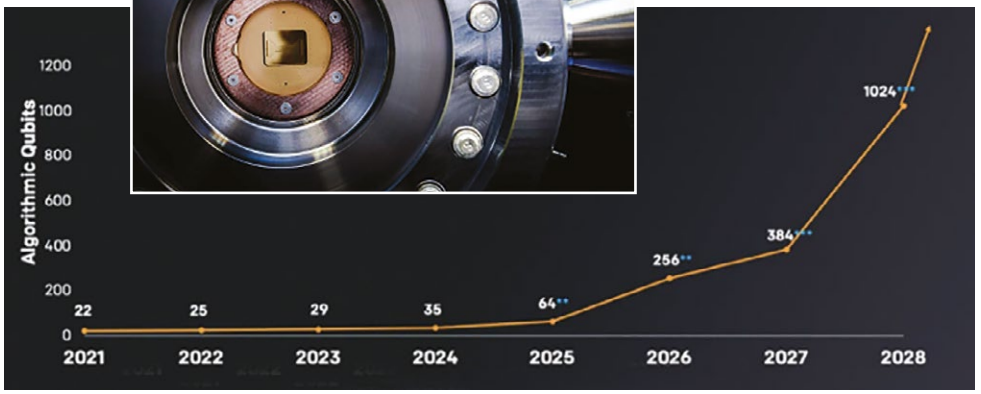
8-9pm Wed.10 May 2023

A brief presentation of the activities in quantum information technology in South Africa with an overview of what quantum information technology involves: quantum communication, quantum computing and quantum sensors.

Presented by Prof Stef Roux

National Metrology Institute of South Africa





nmisa
National Metrology Institute of South Africa

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INSPIRING GREATNESS

Jazz Xpression

Quantum Technology meets Jazz!

8pm Thur 11 May

Andile Yenana Keyboard
Thuto Motseme Bass, Ntokoso Nsibande Trumpet,
Kwena Ramahuta Vocals, Sbu Ncube Drums

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