



Agenda Booklet

Quantum Computing User Forum

July 17-20, 2023

*Hosted by the Oak Ridge Leadership Computing Facility at
Oak Ridge National Laboratory*

Quantum Computing User Forum

The Quantum Computing User Forum brings together users to discuss common practices in the development of applications, software, and simulations for quantum computing devices and systems. The forum is hosted by the Quantum Computing Institute and the Oak Ridge Leadership Computing Facility at Oak Ridge National Laboratory. The forum highlights the results from a broad variety of projects supported by the Quantum Computing User Program which enables more than 400 users to access state-of-the-art quantum computing systems. This program is supported by the US Department of Energy, Office of Science, Advanced Scientific Computing Research program office.

The four-day meeting is scheduled for July 17-20, 2023 at Oak Ridge National Laboratory. The forum agenda includes 4 keynote presentations, 26 invited presentations, and 3 industry-driven workshops from leading researchers in the field of quantum computational science.

Keynote presentations will be provided by Dr. Sarah Sheldon from IBM Quantum, Dr. Russell Stutz from Quantinuum, Dr. Junsang Kim from IonQ, and Mr. Alex McCaskey from NVIDIA.

In addition, three workshops led by IBM, Quantinuum, and Nvidia will be co-located at ORNL during the forum and open to all forum attendees.

Meeting Logistics

Location

- The meeting is located in the Conference Center, on the second floor of Building 5200, at Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Parking

- Park in the Conference Center Parking lot, located north of the traffic circle at the center of the Oak Ridge National Laboratory Campus.

Registration

- Registration is required to attend the meeting.
- Access to ORNL requires approval by the site security office.
- Follow directions in site access email, and pick up your badge at the conference center, follow signs at Building 5200.

Forum Agenda

- All times presented in the agenda reference Eastern Daylight Time (UTC-4).
- Sessions will adhere strictly to the scheduled timetable.

Forum Presentations

- The forum is scheduled as an in-person event only.
- Session chairs will moderate questions as time permits.

Workshop Agendas

- Participation in the workshops is included in registration for the forum.

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Quantum Computing User Forum & Workshops AGENDA

July 17th – 20th, 2023**All times are Eastern Daylight Time (EDT/GMT-4)****Hosted by the Quantum Computing Institute and Oak Ridge Leadership Computing Facility at
Oak Ridge National Laboratory**

The Quantum Computing User Forum brings together users to discuss common practices in the development of applications, software, and simulations for quantum computing devices and systems. Hosted by the Oak Ridge Leadership Computing Facility at Oak Ridge National Laboratory, the meeting includes invited presentations from leading researchers in the field of quantum computer science. This program is supported by the US Department of Energy, Office of Science, Advanced Scientific Computing Research program office.

This agenda contains the times for each presentation from the forum for the keynote talks, invited talks, and poster sessions to be presented July 18-19, as well as the dates and times for the three associated workshops. For more information about this event please visit: <https://www.olcf.ornl.gov/calendar/quantum-computing-user-forum-2023/>

QUICK LOOK: DAYS 1-4

EVENT	DAY	DATE	LOCATION
IBM Workshop	1	7/17	Bldg 5200: Floor 2 Mezzanine and Tennessee Rooms
Quantum Computing User Forum: Sessions 1-4	2	7/18	Bldg 5200: Floor 2 Mezzanine and Tennessee Rooms
Quantum Computing User Forum: Poster Session	2	7/18	Bldg 5200: Floor 2 Mezzanine and Tennessee Rooms
Quantum Computing User Forum: Sessions 5-8	3	7/19	Bldg 5200: Floor 2 Mezzanine and Tennessee Rooms
Quantinum Workshop	4	7/20	Bldg 5200: Floor 2 Mezzanine and Tennessee Rooms
NVIDIA Workshop	4	7/20	Bldg 5200: Floor 2 Mezzanine and Tennessee Rooms

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DAY 1
Monday, July 17th

REGISTRATION

MONDAY BADGING	11:00	12:00	ORNL Visitors Center Bldg 5200
No-host lunch			ORNL Cafeteria Bldg 5200

WORKSHOP

IBM WORKSHOP

IBM WORKSHOP: AFTERNOON SESSION	12:00	17:00	Paul Parazzoli
Opening Remarks	12:00	12:10	
Error Suppression and Mitigation – Part I	12:10	13:40	
Coffee Break with Light Refreshments	13:40	14:00	Sponsored by IBM
Error Suppression and Mitigation – Part II	14:00	14:30	
Qiskit Runtime Primitives	14:30	15:30	
Break	15:30	15:45	
Dynamic Circuits	15:45	17:00	
Adjourn		17:00	

Welcome to the Quantum Computing Workshop, proudly hosted by IBM Quantum. During this workshop, we will introduce [error mitigation and suppression](#) techniques and [dynamic circuits](#). Error mitigation and suppression are critical tools for enhancing the accuracy of quantum calculations. In addition to giving you the background behind these advanced techniques, we will also show how you can easily incorporate them into your solutions using primitives in [Qiskit Runtime](#). A key highlight of our workshop is the introduction of dynamic circuits, a core component of the next wave of high-performance computing, ‘Quantum Centric Supercomputing’. We invite you to join us in exploring the forefront of quantum computing!

For further information about the IBM workshop, IBM will correspond directly by email with Day 1 attendees, and is also available at their website: <https://quantum-enablement.org/events/ornl23.html#ornl23>

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DAY 2
Tuesday, July 18th
QUANTUM COMPUTING USER FORUM

QCUF: MORNING SESSIONS	8:00	11:50	
Tuesday Badging & Continental Breakfast	8:00	8:50	
Welcome to Day 1	8:50	9:00	Travis Humble, ORNL
Session 1	9:00	10:30	Moderator: In-Saeng Suh, ORNL
Keynote: What Can You Do with a Noisy Quantum Computer	9:00	9:50	Sarah Sheldon, IBM
Making Every (Nano)second Count During Quantum Computation with Superstaq	9:50	10:10	Kaitlin Smith, Infleqtion
Long-Time Simulations for Fixed Input States on Quantum Hardware	10:10	10:30	Joe Gibbs, U. of Surrey
Break	10:30	10:50	
Session 2	10:50	11:50	Moderator: Yan Wang, ORNL
Characterizing a Non-Equilibrium Phase Transition on a Quantum Computer	10:50	11:10	Eli Chertkov, Quantinuum
Quantum Embedding Theories to Simulate Condensed Systems on Quantum Computers	11:10	11:30	Marco Govoni, ANL
Quantum Imaginary-Time Evolution Algorithm for Quantum Field Theories with Continuous Variables	11:30	11:50	Kubra Yeter-Aydeniz, Mitre

QCUF: WORKING LUNCH			
Working Lunch	11:50	13:10	Moderator: Claire Marvinney, ORNL
Quantum Computing User Program: Science Engagement and Technology Integration	12:15	12:45	In-Saeng Suh, ORNL Alessandro Baroni, ORNL Antonio Coello Pérez, ORNL Justin Lietz, ORNL

QCUF: AFTERNOON SESSIONS			
Session 3	13:10	14:40	Moderator: Justin Lietz, ORNL
Keynote: Practical Use Cases for Quantum Computers	13:10	14:00	Jungsang Kim, IonQ
Advanced Quantum Poisson Solver for Practical and Scalable Applications	14:00	14:20	In-Saeng Suh, ORNL
Noisy-Intermediate-Scale Quantum Power System Transient Analysis	14:20	14:40	Peng Zhang, Stonybrook University
Break	14:40	15:00	
Session 4	15:00	16:00	Moderator: Alessandro Baroni, ORNL
Studying Dense Neutrino Systems with Quantum Computers	15:00	15:20	Marc Illa Subina, U. of Washington
Quantum Simulation of Open Quantum Systems Relevant for Relativistic Heavy Ion Collisions	15:20	15:40	Xiaojun Yao, U. of Washington
Modeling Singlet Fission on a Quantum Computer	15:40	16:00	Daniel Claudino, ORNL
Announcements: Day 1	16:00	16:15	Travis Humble, ORNL
Forum Photo	16:15	16:30	ORNL Photographer
Break	16:30	17:00	Poster Presenters: Mount Posters

QCUF: EVENING POSTER SESSION	17:00	19:00	Poster Session sponsored by IonQ
Drinks and Hors D'oeuvres	17:00	19:00	Sponsored by IonQ
Poster Presenters & Abstracts in Abstract Booklet	17:00	19:00	
Adjourn Day 1		19:00	Take Down Posters at Close

DAY 3
Wednesday, July 19th

QUANTUM COMPUTING USER FORUM

QCUF: MORNING SESSIONS			
Badging & Continental Breakfast	8:00	8:50	
Welcome to Day 2	8:50	9:00	Travis Humble, ORNL
Session 5	9:00	10:30	Moderator: Francisco Rios, ORNL
Keynote: Recent Progress on H-Series Hardware	9:00	9:50	Russell Stutz, Quantinuum
Quantum Multi-Programming for Grover's Search	9:50	10:10	Kwangmin Yu, BNL
The Learnability of Pauli Noise	10:10	10:30	Senrui Chen, U. of Chicago
Break	10:30	10:50	
Session 6	10:50	11:50	Moderator: Antonio Coello Pérez, ORNL
A Linear Response Framework for Simulating Bosonic and Fermionic Correlation Functions Illustrated on Quantum Computers	10:50	11:10	Alexander Kemper, North Carolina State University
Real-time Subspace Methods for Hamiltonian Eigenvalue Estimation on Quantum Hardware	11:10	11:30	Katherine Klymko, LBNL
Quantum-Parallel Vectorized Data Encodings and Computations on Trapped-Ions and Transmons QPUs	11:30	11:50	Jan Balewski, LBNL
QCUF: WORKING LUNCH			
Working Lunch	11:50	13:10	Moderator: Josh Cunningham, ORNL
Quantum Computing User Program: User Assistance and Software Services	12:15	12:45	Ryan Landfield, ORNL
			Michael Sandoval, ORNL
			Chris Fuson, ORNL
			Susanne Prentice, ORNL
QCUF: AFTERNOON SESSIONS			
Session 7	13:10	14:40	Moderator: Phil Lotshaw, ORNL
Keynote: Defining the Quantum-Accelerated Supercomputer	13:10	14:00	Alex McCaskey, NVIDIA
Comparative Study of Adaptive Variational Quantum Eigensolvers for Multi-Orbital Impurity Models	14:00	14:20	Yongxin Yao, AMES
Quantum Seasoning of Classical Combinatorial Optimization Solvers	14:20	14:40	Maxime Dupont, Rigetti
Break	14:40	15:00	
Session 8	15:00	16:00	Moderator: Tyler LeBlond, ORNL
Entanglement as a Benchmark for Near-Term Quantum Hardware	15:00	15:20	Kathleen Hamilton, ORNL
Optimized Telecloning Circuits: Theory and Practice of Nine NISQ Clones	15:20	15:40	Elijah Pelofske, LANL
Assessing Reliability of Noisy Quantum Computing Devices	15:40	16:00	Samudra Dasgupta, U. of Tennessee
QASMBench: A Low-level QASM Benchmark Suite for NISQ Evaluation and Simulation	16:00	16:20	Ang Li, PNNL
Forum Closing Remarks & Poster Awards	16:20	16:30	Travis Humble, ORNL

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DAY 4
Thursday, July 20th

REGISTRATION & BREAKFAST

THURSDAY ARRIVAL BADGING	7:00	7:30	ORNL Visitors Center Bldg 5200
Working Breakfast	7:30	8:00	Quantinuum Sponsored Breakfast

WORKSHOPS: Part 1

QUANTINUUM WORKSHOP

QUANTINUUM WORKSHOP: MORNING SESSION	8:00	12:00	
Introduction to Quantinuum H-Series and Unique Features	8:00	9:00	Jennifer Strabley and Patty Lee, Quantinuum
Break	9:00	9:10	
TKET User Features	9:10	10:10	Kathrin Spendier, Quantinuum
Break	10:10	10:20	
Quantum Error Correction/Detection/Mitigation on H-Series	10:20	11:20	Natalie Brown, Quantinuum
Break	11:20	11:30	
Quantinuum Q&A Panel			Moderator: Jennifer Strabley, Quantinuum
Panelist discussion	11:30	12:00	Natalie Brown, Quantinuum
			Patty Lee, Quantinuum
			Kathrin Spendier, Quantinuum
			Russell Stutz, Quantinuum
Adjourn		12:00	

This workshop consists of three sections that cover various aspects of the Quantinuum H-Series platform. It concludes with a Quantinuum Q&A Panel, allowing participants to address any queries regarding the platform.

1) Introduction to Quantinuum H-Series and Unique Features:

In this section, we will highlight the unique features of [Quantinuum H-Series](#) trapped ion quantum computers, such as high two-qubit gate fidelity, full connectivity, qubit re-use, mid-circuit measurement, conditional logic, and arbitrary angle single-qubit and two-qubit gates. We will also discuss how to take advantage of these unique features and showcase examples of actual circuits that have been run on the hardware using these features.

2) TKET User Features: This section highlights the powerful features of [TKET](#), Quantinuum's advanced software development kit (SDK). Among other topics, participants will learn about [PyTKET](#), circuit submission to H-series devices, compilation options, emulator usage with noise models, mid-circuit measurement, and circuit conversion to and from other SDKs. They will also explore performance optimization for IBM and other platforms.

3) Quantum Error Correction/Detection/Mitigation on H-Series: Participants will study error correction and mitigation on the H-Series platform, including real-time decoding with color code, two-qubit gates, and circuit construction using OpenQASM and [QIR](#). The session also covers error detection via [Iceberg code](#)

For further information about the Quantinuum Workshop, Quantinuum will correspond directly by email with Day 4 attendees.

THURSDAY BREAK	12:00	13:00	
No-host lunch	12:00	13:00	ORNL Cafeteria Bldg 5200

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DAY 4
Thursday, July 20th

WORKSHOPS: Part 2

NVIDIA WORKSHOP

NVIDIA WORKSHOP: AFTERNOON SESSION	13:00	17:00	Pooja Rao
Session 1: Introduction			
Introduction to CUDA Quantum	13:00	13:50	
Break	13:50	14:00	
Session 2: Demonstration & Hands-On			
Developing Applications with CUDA Quantum on Various Quantum-Classical Computing Architectures	14:00	15:30	
Break	15:30	15:45	
Session 3: Projects			
Participants Choice / Standard Projects Provided by NVIDIA	15:45	17:00	
Adjourn		17:00	

In this workshop, we will introduce the CUDA Quantum programming model and compilation platform. CUDA Quantum has been designed specifically for quantum acceleration of existing classically heterogeneous workflows and applications. The workshop will acquaint participants with the programming model in both C++ and Python, and walk through the development of quantum-classical application code that leverages NVIDIA GPUs for performant circuit simulation. The primary application codes we will demonstrate will be hybrid quantum-classical applications prevalent in quantum chemistry and machine learning. Attendees will work through quantum kernel development for near-term quantum computation, as well as mid-circuit measurement and fast feedback for future fault tolerant applications.

We will demonstrate the use of simulation backends that leverage one or many NVIDIA GPUs, as well as programming and execution models that incorporate multiple QPUs via GPU-emulation on a multi-GPU compute node.

In the last part of the workshop, the participants will be encouraged to experiment with a set of predefined application goals, or port their own applications in CUDA Quantum using the C++ interface and/or the user-friendly Python API.

*For further information about the NVIDIA Workshop, NVIDIA and OLCF will correspond directly by email with Day 4 attendees:
 -there are pre-requisite requirements that will be emailed to attendees for the hands-on demonstrations with CUDA Quantum*

END OF FORUM & WORKSHOPS		17:00	
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