2022
Conference
Program

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CONFERENCE & EXPO

IEEE QUANTUM WEEK

IEEE International Conference on Quantum Computing and Engineering (QCE22)

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IEEE QUANTUM WEEK

IEEE International Conference on Quantum Computing and Engineering (QCE22)

Welcome!

IEEE Quantum Week is a multidisciplinary quantum computing and engineering venue where attendees have the unique opportunity to discuss challenges and opportunities with quantum researchers, scientists, engineers, entrepreneurs, developers, students, practitioners, educators, programmers, and newcomers.

Have a great week at IEEE Quantum Week 2022!

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Access Online Schedule →

Chairs' Message

Greg Byrd, Bert de Jong, and Hausi Müller

Welcome to the third *IEEE International Conference on Quantum Computing and Engineering (QCE22)* or *IEEE Quantum Week*. With your outstanding contributions and participation, Quantum Week offers a valuable opportunity to interact with experts in a full range of quantum technologies, from quantum device engineering to quantum computing and applications. From its beginning, a goal of IEEE Quantum Week has been to enable a meaningful exchange of ideas and to broaden the quantum community through networking with peers and exploring partnerships among industry, government, and academia. We hope that you will agree that this year's program delivers on all fronts.

We are pleased to hold IEEE Quantum Week 2022 as an in-person conference for the first time. We were all set to hold the first conference (2020) in Broomfield, Colorado, but the COVID-19 pandemic forced us to switch to a fully virtual format. That first conference had more than 800 attendees, and we learned a lot about the challenges and opportunities of a virtual conference. Again, we offered virtual-only in 2021, growing the program and attracting more than 1,100 participants. This year, we are able to gather together in one physical space, and the program features opportunities for networking and social interactions, including exhibits, breaks, extended lunches, receptions, and a banquet. We are very

Let’s build a quantum future together

When we launched the world’s first quantum computer on IBM Cloud in 2016, we were astonished to gain 8,000 users in a few weeks.

Today, we have a community of more than 400,000, the largest in the world. These open-source quantum developers have run more than 1 trillion circuits (and counting on more than 20 cloud-connected IBM Quantum systems. These are the best quantum computers in the world.

We now have 180+ active clients in the IBM Quantum Network, including Goldman Sachs, The University of Tokyo, Fraunhofer, and Cleveland Clinic.

In 2021 we broke the 100-qubit barrier with the 127-qubit Eagle processor. Now we are on track to unveil a 433-qubit Osprey processor by the end of 2022 and a 1,121-qubit Condor in 2023. Our development roadmap now includes targets for creating new technology necessary to develop even larger quantum systems. This is just the beginning. If you are as excited about what quantum computing can do for your organization as we are, then we should talk.

If you’d like to learn more, please contact us at: hmcortes@us.ibm.com

IBM **Quantum**

IBM

much looking forward to the chance to meet and interact in person.

At the same time, we realize that some are not able to travel, for many reasons. We have therefore arranged for almost all 2022 IEEE Quantum Week events to be offered using the Hubb virtual platform. This is the same online platform that we used for the 2020 and 2021 events. This will allow virtual attendees from around the world to participate in real time, interacting with on-site attendees and presenters. In addition, all streamed content will be recorded and will be available on-demand to all registered attendees through November 15.

Providing both in-person and virtual access to all sessions is challenging, but we strongly believe that IEEE Quantum Week offers a unique opportunity for the broad quantum research, development, and user communities to meet and exchange perspectives. To be a truly international conference, our goal is that physical distance should not be an impediment to participation. We hope that both in-person and remote attendees will take full advantage of the extensive program.

QCE22 features ten parallel tracks over five days, including 9 keynotes by world-class speakers, 26 workforce-building tutorials, 16 community-building workshops, 70 technical papers, 13 stimulating panels, 60 innovative posters, and 5 thought-provoking Birds of Feather (BoF) sessions. Except for posters, all of these sessions will be interactively delivered to virtual attendees through the Hubb platform. Poster presenters will showcase their ideas in the form of a short video on Hubb.

In addition, we will have an exhibit space representing a broad cross-section of the quantum ecosystem. Our 40+ exhibitors, sponsors, and supporters form a key part of the IEEE Quantum Week experience, building bridges between academia, industry, and government research. All sponsors will also host online sessions to interact with all attendees. Students have the opportunity to interact with industry mentors in a breakfast panel.

Our keynote program features nine outstanding speakers from industry, academia, and research labs. They anchor the morning and evening of each day of programming, offering insights into the latest progress and potential for quantum technologies and applications.

The technical papers program is organized into four tracks: (1) Quantum Applications and Algorithms, (2) Quantum Systems Software, (3) Quantum Networking and Communications, (4) Quantum Computing Hardware Engineering. QCE22 received 143 technical paper submissions—a 40% increase over 2021. More than 40% of submitted papers had at least one author from industry or government laboratories. Papers were submitted by authors from 29 countries on 4 continents, and 45% of the authors were from outside North America—evidence of the international reach of the conference and the quantum research community. Each track had its own program committee, managed by two track co-chairs. Each paper received at least three reviews from 90 international program committee members. Based on the reviews and further discussion, 70 papers were selected for presentation.

The rest of the program also reflects the international nature of IEEE Quantum Week. About half of the workshops, tutorials, panels, and birds-of-a-feather sessions involve non-US organizers. More than 70 posters were submitted by authors from 24 different countries, with 60 posters selected for presentation.

We are deeply indebted to very many people for their help and support in orchestrating QCE22. First, we would like to thank all the contributors—the keynote speakers, the technical paper and poster authors, the panel organizers and panelists, the tutorial presenters, the workshop organizers, and the BoF orchestrators. We especially would like to thank the exhibitors—the Diamond, Platinum, Gold, Silver, Bronze sponsors and patrons, and the supporters for their financial, technical, and in-kind contributions.

Second, we would like to thank all attendees who registered for QCE22. Your enthusiasm and appreciation of the speakers and the program make it all worthwhile. We've gotten to know many of you over the last three years, but we are especially happy that we are able to interact with many of you in person this year. Please continue to give us feedback about what you liked, as well as your ideas about how to the improve the conference in the future.

Third, we thank all technical program track chairs and committee members, who conducted the review process under the leadership of the Technical Program Board Chair Bert de Jong. We also thank the co-chairs and reviewers of the tutorial, workshop, poster, panel tracks for their dedication and innovative ideas in soliciting proposals. The track co-chairs and committee members are enumerated and recognized in the QCE22 Committee pages below in detail. Finally, we are indebted to the union of the IEEE Quantum Week Steering Committee and the IEEE Quantum Initiative Steering Committee for their extensive contributions, feedback, and support in the *weekly* conference calls over the past twelve months. These folks greatly shaped the structure and format of IEEE Quantum Week 2022.

We are deeply indebted all the IEEE staff who worked tirelessly over the last year (and more!) in bringing IEEE Quantum Week 2022 to fruition. First and foremost, we thank Terence Martinez, IEEE Quantum Initiative Program Director at IEEE Future Directions, for his dedicated support. Terence orchestrated our weekly conference calls, liaised to all the IEEE Societies and organizational units sponsoring IEEE Quantum Week, organized the QCE22 publicity campaign at the IEEE level, and kept us on track. We thank all the staff at IEEE, IEEE Future Directions, and the different sponsoring societies, councils, and organizational units for promoting IEEE Quantum Week in their respective channels.

We especially commend the staff of IEEE Computer Society, the official QCE22 Conference Management Organization, for their superb help and support throughout the entire journey of IEEE Quantum Week. First, we thank Silvia Ceballos, who believed in the concept of IEEE Quantum Week and encouraged us to take on this journey. Second, we would like to thank our outstanding meeting planner, Carmen Saliba, for her outstanding project management skills, her attention to details, and for looking after IEEE Quantum Week and its volunteers. She conducted all our contract negotiations with the hotel, the virtualization company, registration services, and many more. She was the perfect interface to IEEE Computer Society staff and services. We thank Patrick Kellenberger and Cristina Ceballos for their outstanding Conference Publications Services (CPS) and Marie Trinh and Tricia Yamaguchi for their Registration Services. We especially thank the outstanding exhibits team that exceeded all our exhibits sales expectations, including Michelle Tubb, Regan Pickett, Georgann Carter, and Amir Draquez. Marketing is critical for an emerging conference, and we are deeply indebted to Katherine Mansfield and Michelle Tubb for leading this activity. We especially thank Stephen Woods for his outstanding technical and IT support and for being patient and solving many problems in our first hybrid in-person and virtual event.

Whether you attend IEEE Quantum Week 2022 in person or online, we hope that you will find the program and the events to be a great experience. We want you to enjoy the conference this week, meet new colleagues, and find plenty of time in the weeks to come to explore the many outstanding contributions from the international quantum community.

Greg Byrd
QCE22 General Chair
NC State University

Bert de Jong
QCE22 Program Chair
Lawrence Berkeley National Laboratory

Hausi Müller
QCE22 Finance Chair
Co-Chair IEEE Quantum Initiative
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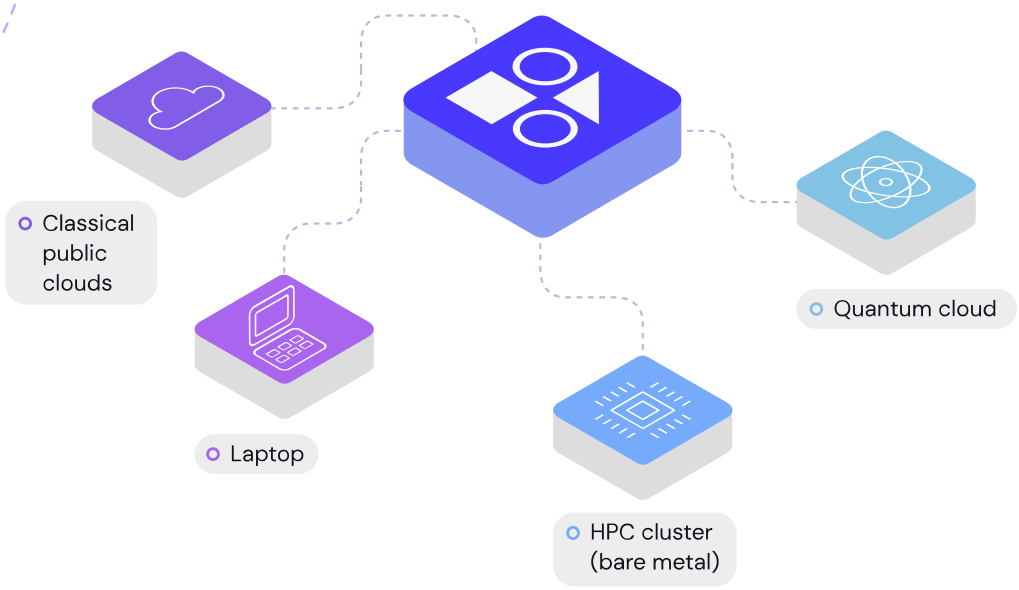

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With your support, we are pleased to present the IEEE International Conference on Quantum Computing and Engineering (QCE22), a multidisciplinary event focusing on quantum technology, research, development, and training.

We are grateful to our amazing lineup of sponsors for being a part of Quantum Week.

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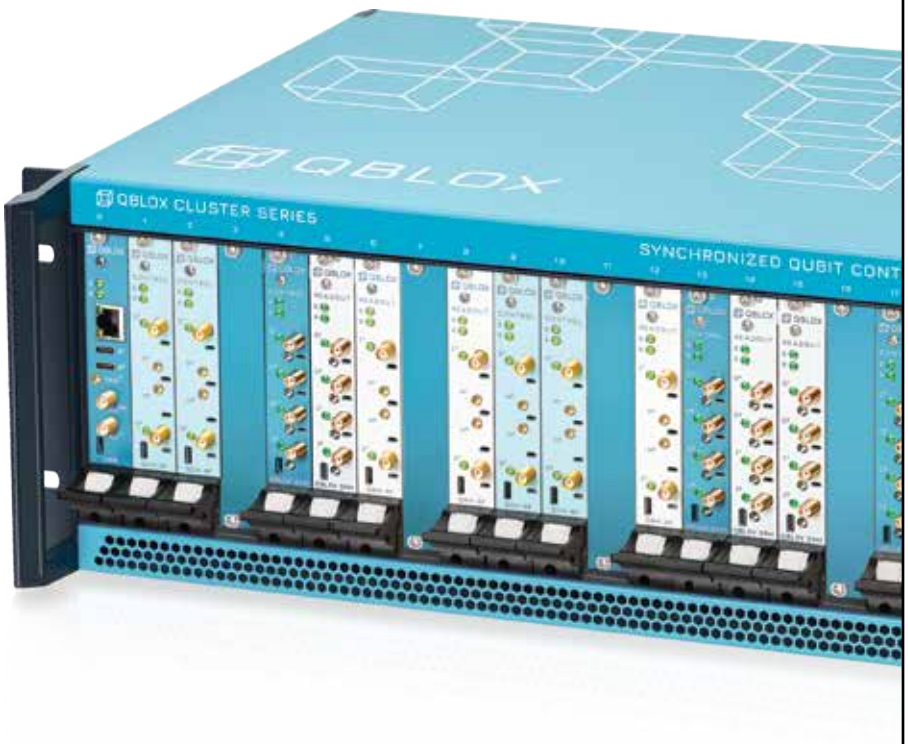
Sponsor Event Highlights

Mountain Time (UTC-6)	Event	Company
Mon, 19 Sept 11:30 am– 1:00 pm	**Meet the Azure Quantum Team Authors—Cassandra Granade: Learn Quantum Computing with Python and Q#** The Microsoft Azure Quantum booth in the expo will be staffed by subject matter experts from our engineering team throughout the week, including quantum book authors Cassandra Granade, Mariia Mykhailova and Leonard Woody. Please stop by to say hello and chat with our team.	Microsoft Azure Quantum
Mon, 19 Sept 12:00– 12:45 pm Virtual Session →	**Quantropi: Fighting Quantum With Quantum** An introduction to the cybersecurity threat posed by quantum computers and how Quantropi leverages quantum mechanics to address these vulnerabilities. Join us to learn how to use the power of uncertainty and the Quantum-against-Quantum approach to secure against the quantum threat!	Quantropi Inc.
Tue, 20 Sept 10:00– 11:00 am Virtual Session →	**Leading the Next Materials Leap in Quantum Computing** Quantum computing has the potential to change our lives. With applications ranging from enabling better and faster drug discovery to evaluating solutions to address climate change, the economic impact of the quantum industry will be on the same scale as the semiconductor industry. C12 builds next generation quantum computers powered by the most elementary material: carbon nanotubes.	C12 Quantum Electronics

Control The Quantum Future



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Visit our booth at IEEE Quantum Week | Broomfield - Colorado or visit us online www.qblox.com

Sponsor Event Highlights, continued

Mountain Time (UTC-6)	Event	Company
Wed, 21 Sept 10:00– 11:00 am	**Fully Integrated Quantum Control Stacks from a handful to 100s of Qubits** Reaching NISQ applications hinges on improvements in the gate fidelity and qubit number. Qblox supports this with time-efficient, ultralow-noise, and cost-effective control stacks. We introduce the modular Cluster system which incorporates up to 120 Q1 processors capable of sequencing pulses, their parameters, and measurement operations in real time. This architecture speeds up experiments by orders of magnitude as it avoids the overhead caused by software-controlled loops. This speed-up is realized by multi-parameter real-time pulse modification and by on-board data processing (integrating, averaging, binning) of readout signals and storing up to 131072 measurement results per experimental run. The state-of-the-art signal noise level (14 nV/√Hz @ 1 MHz and 5 Vpp) supports improved gate fidelities and the low gain and offset drift (a few ppm/K) reduces the need for recalibrations. The Cluster supports many qubit platforms with its wide frequency range from DC to 18.5 GHz while occupying less volume than 1 liter per controlled qubit. Quantify—an open-source python framework—manages the hardware stack, which allows hybrid scheduling of gate-level and pulse-level descriptions. This full-stack approach opens a fast track for gate optimizations and scaling efforts towards running NISQ applications.	Qblox BV

Sponsor Event Highlights, continued

Mountain Time (UTC-6)	Event	Company
Wed, 21 Sept 11:30 am–1:00 pm	**Meet the Azure Quantum Team Authors— Mariia Mykhailova: Q# Pocket Guide** The Microsoft Azure Quantum booth in the expo will be staffed by subject matter experts from our engineering team throughout the week, including quantum book authors Cassandra Granade, Mariia Mykhailova and Leonard Woody. Please stop by to say hello and chat with our team.	Microsoft Azure Quantum
Wed, 21 Sept 12:00–1:00 pm	**Managing High-Performance Classical and Quantum Workflows with Covalent** Covalent is an open-source workflow orchestration platform designed to help users manage and execute tasks on high performance and quantum computing resources. Come to our booth on Tuesday (Sept 20th) at 12pm to catch a live demo of Covalent and ask any questions you might have. You can learn more at www.covalent.xyz	Agnostiq
Wed, 21 Sept 12:00–12:45 pm  Virtual Session →	**Quantropi: Fighting Quantum With Quantum** An introduction to the cybersecurity threat posed by quantum computers and how Quantropi leverages quantum mechanics to address these vulnerabilities. Join us to learn how to use the power of uncertainty and the Quantum-against-Quantum approach to secure against the quantum threat!	Quantropi Inc.

Sponsor Event Highlights, continued

Mountain Time (UTC-6)	Event	Company
Thu, 22 Sept 10:30–11:00 am	**AMA with Sayonee Ray, Quantum Applications Scientist at IonQ** Do you have questions? We have answers! Join our AMA with Sayonee Ray, a Quantum Applications Scientist at IonQ, for an "Ask Me Anything" session. Curious about what are quantum applications and how are they relevant in the present day world? Want to learn more about the future of quantum technologies and how IonQ is shaping this future or perhaps what it's like working at IonQ? What does IonQ's work culture and DEI look like? How can you join our team? Join us for this casual conversation, exclusive for virtual attendees.	IonQ
Thu, 22 Sept 11:30 am–1:00 pm	**Meet the Azure Quantum Team Authors— Leonard Woody: Essential Mathematics for Quantum Computing** The Microsoft Azure Quantum booth in the expo will be staffed by subject matter experts from our engineering team throughout the week, including quantum book authors Cassandra Granade, Mariia Mykhailova and Leonard Woody. Please stop by to say hello and chat with our team.	Microsoft Azure Quantum
Fri, 23 Sept 12:00–12:45 pm  Virtual Session →	**Quantropi: Fighting Quantum With Quantum** An introduction to the cybersecurity threat posed by quantum computers and how Quantropi leverages quantum mechanics to address these vulnerabilities. Join us to learn how to use the power of uncertainty and the Quantum-against-Quantum approach to secure against the quantum threat!	Quantropi Inc.

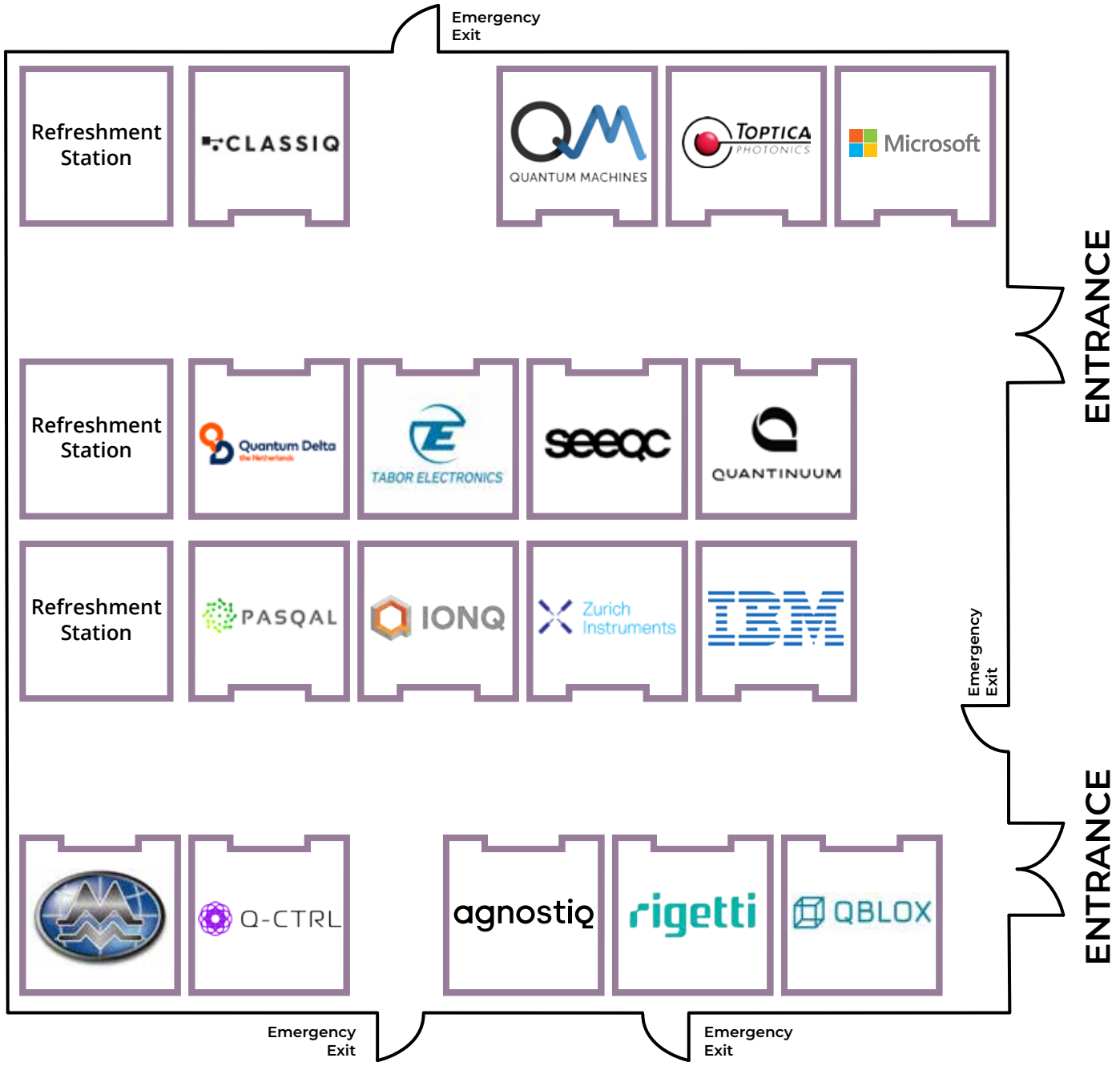
IEEE QUANTUM WEEK

Conference Maps

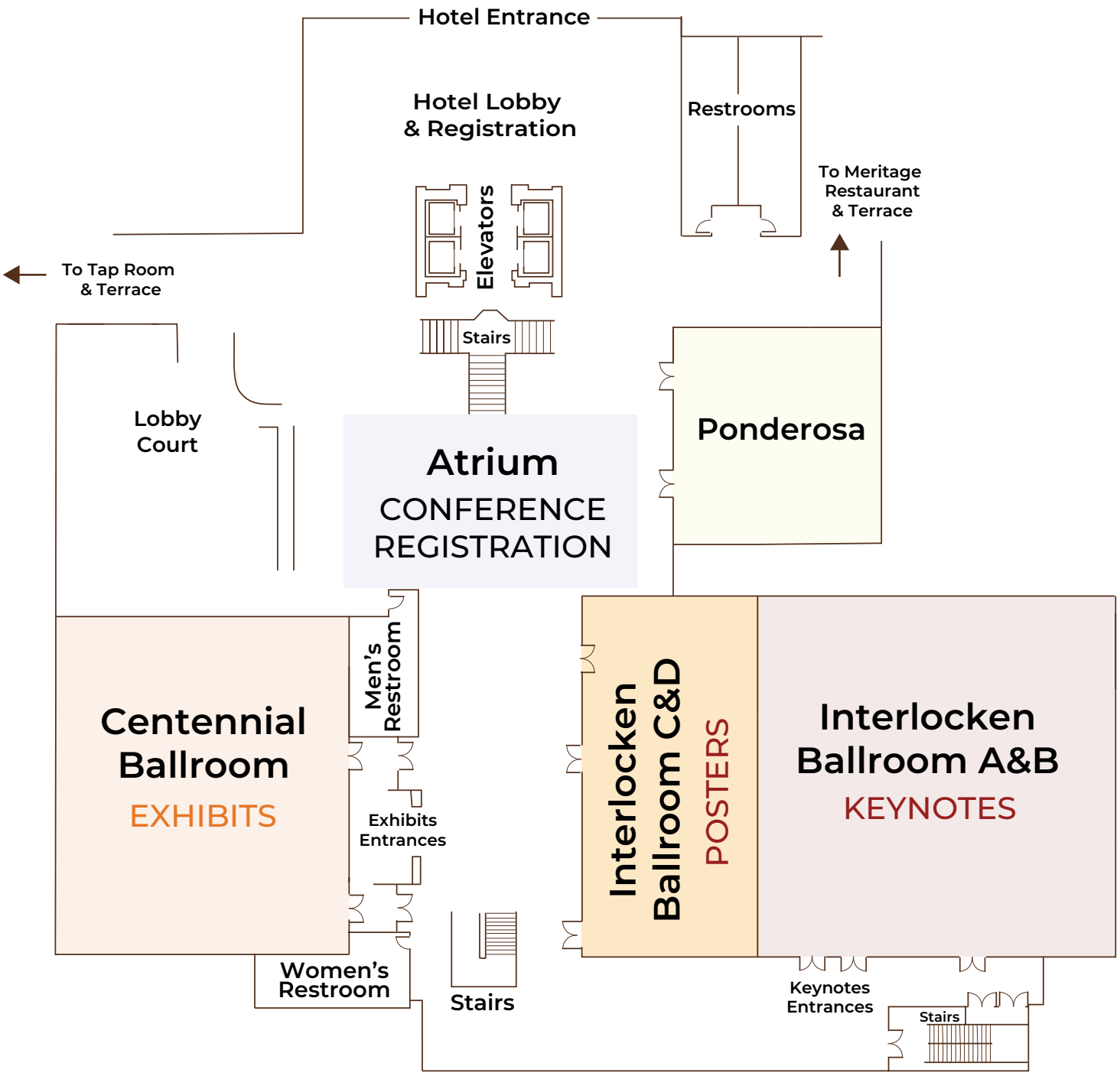
Omni Interlocken Hotel
Broomfield, Colorado, USA

Exhibitor Map

Centennial Ballroom

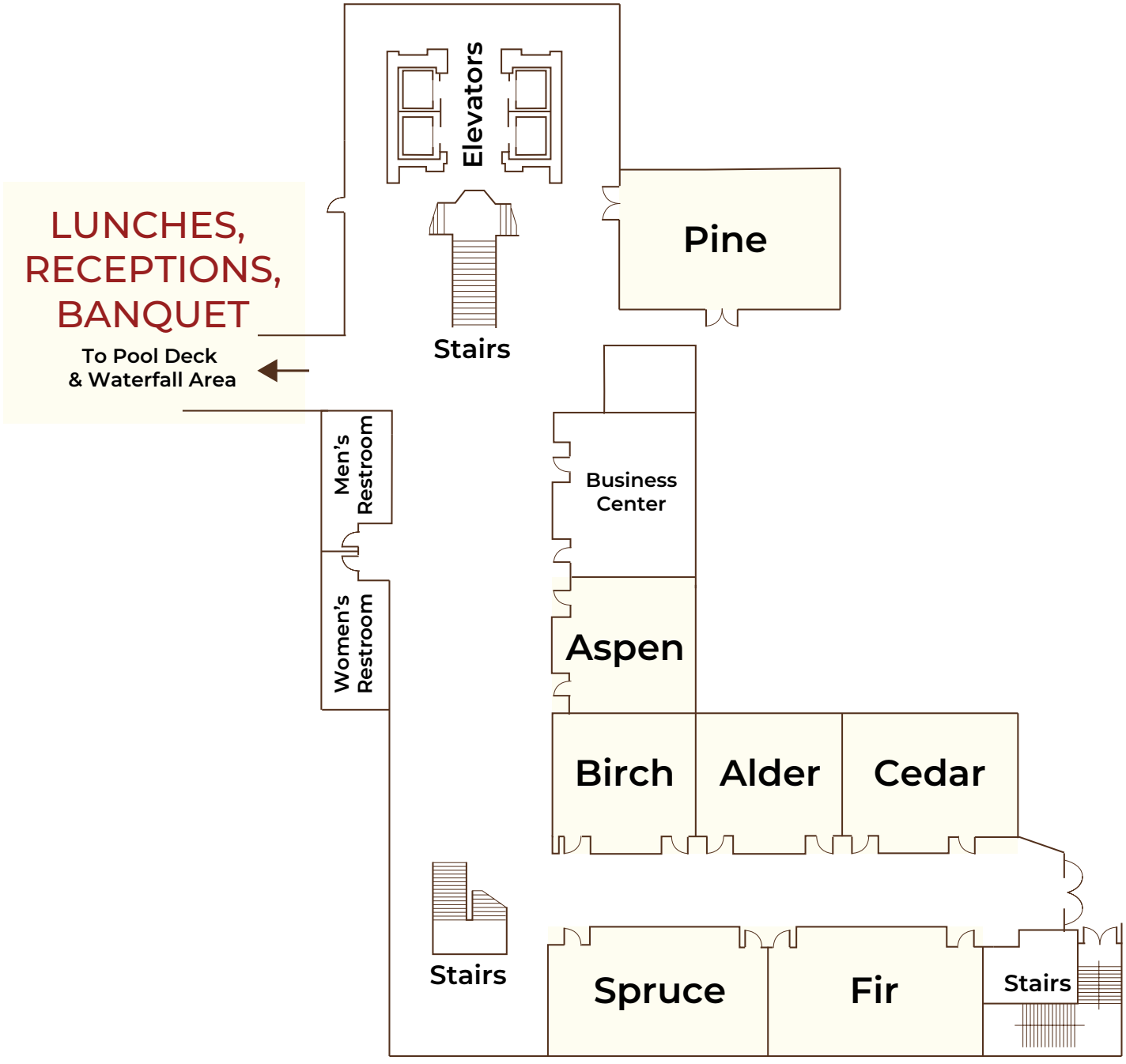


Interlocken First Floor



Interlocken Second Floor

Garden Level



General Conference Information

In-Person and Virtual: Logistics for IEEE Quantum Week 2022

We have planned IEEE Quantum Week 2022 as primarily an in-person event with virtual components. As we realize that some may not be able to travel for many reasons, we have arranged for almost all Quantum Week events to be offered using the Hubb virtual platform. This will allow virtual attendees from around the world to participate in real-time, interacting with on-site attendees. In addition, **all streamed content will be recorded and will be available on-demand to all attendees through 15 November 2022, for registered participants.**

The following types of sessions will be streamed and recorded: keynotes, workshops, tutorials, technical paper sessions, panels, and Birds-of-a-Feather (BoF) sessions. All of these sessions will use hosted Zoom rooms through the Hubb virtual platform, allowing for engagement with the online attendees. All presentations will be live, and pre-recorded presentations will not be supported. The Session Chair for each session must be in person so that the interaction between speakers and attendees is driven from the room.

The following activities will not be available to virtual attendees: poster sessions, breaks, receptions, banquet, and access to the exhibit space. Poster authors will have short videos available for all attendees to view. In addition, there will be opportunities for online attendees to meet with corporate sponsors.

QUICK LINKS

Virtual Conference Best Practices and Recommended Browsers

QCE Registration

To be a truly international conference, our goal is that physical distance should not be an impediment to participation—we hope that both in-person and remote attendees will take full advantage of the extensive program.

Thank you very much for your patience and support in working through the in-person and virtual logistics for IEEE Quantum Week 2022.

Access Online Schedule →

Uniform Daily Schedules

Mountain Time (UTC-6)	Sunday Sessions
8:00–10:00	Workshops
10:00–16:45	Workshops, Tutorials, Lunch, Breaks
15:00–17:00	Panels
17:00	Networking Reception

Mountain Time (UTC-6)	Monday–Friday Sessions
8:00–9:15	Keynotes, Awards, Announcements
9:15–10:00	Breaks, Exhibits, Posters
10:00–11:30	Papers, Panels, Tutorials, Workshops, BoFs
11:30–13:00	Lunch, Exhibits
13:00–14:30	Papers, Panels, Tutorials, Workshops
14:30–15:15	Breaks, Exhibits, Posters
15:15–16:45	Papers, Panels, Tutorials, Workshops, BoFs
16:45–17:30	Breaks
17:30–18:45	Keynotes
18:45–20:30	Receptions, Exhibits, Banquet

IEEE QUANTUM WEEK

Program Legend

Keynotes — Interlocken Ballroom A&B	Posters — Interlocken Ballroom C&D
Panels	Birds of a Feather (BoF)
Exhibits — Centennial Ballroom	Virtual Relax & Recharge Room
Tutorials	Meals and Breaks
Workshops	
Technical Paper Tracks	

Virtual Only Session

QCE22 Program — Sun, 18 Sept

MT (UTC-6)	Session Type	Session Room	Sunday Sessions
8:00–10:00	Workshop	Spruce & Fir	Osinski, Yeh, PAS, UOxford: Quantum Sci & Engr Edu (QSEEC)
10:00–16:45	Workshop	Spruce & Fir	Osinski, Yeh, PAS, UOxford: Quantum Sci & Engr Edu (QSEEC) (Lunch and Breaks included)
	Workshop	Aspen	Angara, U Victoria, Quantinuum: Pathways to QC for Youth (Lunch and Breaks included)
10:00–13:30	Tutorial	Virtual	LibKet: X-Platform Lib for Quantum Algorithms (Break included)
14:00–17:30	Tutorial	Virtual	Quantuloop: Quantum Programming with Ket (Break included)

Access Online Schedule →

MT (UTC-6)	Session Type	Session Room	Sunday Sessions
15:00–17:00	Panel	Ponderosa	Two Panels: • How Quantum Technology is Transforming • Industry Sectors—Full Stack Quantum Solutions by QCE22 Sponsors
17:00–18:30	Networking Reception	Pavillion	End User Networking Reception

QCE22 Program — Mon, 19 Sept

MT (UTC-6)	Session Type	Session Room	Monday Sessions
8:00–9:15	Keynote	Interlocken Ballroom AB	Chris Monroe, IonQ & DukeU: Quantum Computing with Atoms
09:15–10:00	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
	Posters	Interlocken Ballroom CD	Posters
09:30–11:10	Panel	Ponderosa	Student Mentorship Breakfast (Pre-registration is required)
10:00–11:30	Papers	Birch	QAA Optimization
	Workshop	Interlocken B	ORNL, ANL, FNAL, NASA, NVIDIA: Adv Quantum Simulation - Part1
	Workshop	Interlocken A	Taylor, Riverlane: Defining Roadmap to Error-corrected QComputers
	Tutorial	Pine	Pakin, Rieffel, LANL, NASA: Quantum Computing Intro - Part1
	Workshop	Spruce	Chen, Wong, Sotelo: Quantum Computing Entrepreneurship
	Tutorial	Fir	TorchQuantum: Library for Parameterized Quantum Circuits
	Tutorial	Cedar	Intel Quantum SDK: Platform for Variational Algorithms
	BoF	Cedar	Rise of AI Lawyer: Human/Non-Human Intelligence in Quantum Logic
11:30–13:00	Lunch	Pavillion	Lunch
	Exhibits	Centennial Ballroom	Exhibits
13:00–14:30	Papers	Birch	QAA Classification-1
	Workshop	Interlocken B	ORNL, ANL, FNAL, NASA, NVIDIA: Adv Quantum Simulation - Part1
	Tutorial	Ponderosa	CMU: Classiq Platform to Optimize Circuits from Models

Access Online Schedule →

MT (UTC-6)	Session Type	Session Room	Monday Sessions
13:00–14:30	Workshop	Interlocken A	Taylor, Riverlane: Defining Roadmap to Error-corrected QComputers
	Tutorial	Pine	Pakin, Rieffel, LANL, NASA: Quantum Computing Intro - Part1
	Workshop	Spruce	Chen, Wong, Sotelo: Quantum Computing Entrepreneurship
	Tutorial	Fir	TorchQuantum: Library for Parameterized Quantum Circuits
	Tutorial	Cedar	Intel Quantum SDK: Platform for Variational Algorithms

MT (UTC-6)	Session Type	Session Room	Monday Sessions
13:00–14:30	Tutorial	Cedar	Quantum Noise Characterization and Mitigation
	Papers	Aspen	QCHE Quantum Hardware-1
14:30–15:15	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
	Posters	Interlocken Ballroom CD	Posters
15:15–16:45	Papers	Birch	QAA Classification-2
	Workshop	Interlocken B	ORNL, ANL, FNAL, NASA, NVIDIA: Adv Quantum Simulation - Part1
	Tutorial	Ponderosa	CMU: Classiq Platform to Optimize Circuits from Models
	Workshop	Interlocken A	Taylor, Riverlane: Defining Roadmap to Error-corrected QComputers
	Panel	Pine	Atom Computing, AWS, UIUC, LM: Quantum Workforce
	Workshop	Spruce	Chen, Wong, Sotelo: Quantum Computing Entrepreneurship
	Panel	Fir	Classiq, ColdQuanta: Coding competitions & hackathons
	BoF	Fir	Jaynes, Frantz: Quantum Standards
	Tutorial	Cedar	Quantum Noise Characterization and Mitigation
	Papers	Aspen	QCHE Quantum Hardware-2
16:45–17:30	Break		Break
17:30–18:45	Keynote	Interlocken Ballroom AB	Fred Chong, U-Chicago & ColdQuanta: Closing Gap between Algorithms & Machines with HW-SW Co-Design
18:45–20:30	Reception	Pavillion	Reception
	Exhibits	Centennial Ballroom	Exhibits

Access Online Schedule →

QCE22 Program — Tue, 20 Sept

MT (UTC-6)	Session Type	Session Room	Tuesday Sessions
8:00–9:15	Keynote	Interlocken Ballroom AB	Mercedes Gimeno Segovia, PsiQuantum: Fault-tolerant Quantum Computing with Photonics
09:15–10:00	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
	Posters	Interlocken Ballroom CD	Posters

MT (UTC-6)	Session Type	Session Room	Tuesday Sessions
10:00–11:30	Papers	Birch	QAA Encoding-1
	Workshop	Interlocken A	Zanner, Mykhailova, Microsoft: Quantum Azure: Res, Edu, Innovation
	Tutorial	Ponderosa	QM: Real-time Quantum Control via Intuitive Software
	Workshop	Interlocken B	ORNL, ANL, FNAL, NASA, NVIDIA: Adv Quantum Simulation - Part2
	Tutorial	Pine	Pakin, Rieffel, LANL, NASA: Quantum Computing Intro - Part2
	Workshop	Fir	Nowrouzi, Butko, Huang, LBNL: Classical Control Systems for QC
	Panel	Spruce	Atom C, AWS, LM, NuQuantum, UC: How to engage with QC industry
	Workshop	Alder	Sotelo, Wang, Nakamura, IEEE CTSoc: Quantum Consumer Technology
	Panel	Cedar	QPARC Quantum Chemistry Hackathon Challenge
	Papers	Aspen	QNC Quantum Internet
11:30–13:00	Lunch	Pavillion	Lunch
	Exhibits	Centennial Ballroom	Exhibits
13:00–14:30	Papers	Birch	QAA Encoding-2
	Workshop	Interlocken A	Zanner, Mykhailova, Microsoft: Quantum Azure: Res, Edu, Innovation
	Tutorial	Ponderosa	QM: Real-time Quantum Control via Intuitive Software
	Workshop	Interlocken B	ORNL, ANL, FNAL, NASA, NVIDIA: Adv Quantum Simulation - Part2
	Tutorial	Pine	Pakin, Rieffel, LANL, NASA: Quantum Computing Intro - Part2
	Workshop	Fir	Nowrouzi, Butko, Huang, LBNL: Classical Control Systems for QC
	Tutorial	Spruce	Algorithm Development with Qiskit Runtime Primitives
	Workshop	Alder	Sotelo, Wang, Nakamura, IEEE CTSoc: Quantum Consumer Technology

Access Online Schedule →

MT (UTC-6)	Session Type	Session Room	Tuesday Sessions
13:00–14:30	Tutorial	Cedar	QunaSys: QC Chemistry Application for Energy: Hands-on
	Papers	Aspen	QSS Compilation-1
14:30–15:15	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
	Posters	Interlocken Ballroom CD	Posters

MT (UTC-6)	Session Type	Session Room	Tuesday Sessions
15:15–16:45	Papers	Birch	QAA Characterization
	Workshop	Interlocken A	Zanner, Mykhailova, Microsoft: Quantum Azure: Res, Edu, Innovation
15:15–16:45	Panel	Ponderosa	ORNL, ICHEC: Quantum Computers in HPC Centers
	Workshop	Interlocken B	ORNL, ANL, FNAL, NASA, NVIDIA: Adv Quantum Simulation - Part2
	Panel	Pine	Quantinuum: The Quantum Foundry
	Workshop	Fir	Nowrouzi, Butko, Huang, LBNL: Classical Control Systems for QC
	Tutorial	Spruce	Algorithm Development with Qiskit Runtime Primitives
	Workshop	Alder	Sotelo, Wang, Nakamura, IEEE CTSoc: Quantum Consumer Technology
	Tutorial	Cedar	QunaSys: QC Chemistry Application for Energy: Hands-on
	Papers	Aspen	QSS Compilation-2
16:45–17:30	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
17:30–18:45	Keynote	Interlocken Ballroom AB	Michael Biercuk, C-CTRL & U-Sydney: Making QEC Practical with Quantum Control Infrastructure Software
18:45–20:30	Reception	Pavillion	Reception with sponsors and exhibitors

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QCE22 Program — Wed, 21 Sept

MT (UTC-6)	Session Type	Session Room	Wednesday Sessions
8:00–9:15	Keynote	Interlocken Ballroom AB	Stephanie Wehner, TU Delft & Qtech: Quantum Networks: From Physics to Network Systems
09:15–10:00	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
	Posters	Interlocken Ballroom CD	Posters

MT (UTC-6)	Session Type	Session Room	Wednesday Sessions
10:00–11:30	Papers	Birch	QSS Analysis
	Workshop	Interlocken A	Schulz, TU Munich, TU Denmark, Leibniz SC: Integrating HPC with QC
	Panel	Ponderosa	Quantinuum: Architectures for Logical Qubits
	Workshop	Interlocken B	Date, Hamilton, Delgado, ORNL: Quantum Artificial Intelligence
	Tutorial	Spruce	Q-CTRL: Quantum Control: Quantum Technology Potential
	Workshop	Pine	Giani, Huang, GE Res & PNNL: QC Renewable Energy & Climate Change
	Tutorial	Alder	Mishar, US Army: Intro to Quantum Comm & Internet
	BoF	Cedar	Quantum Software Engineering: Workforce, Skills, Best Practices
	Tutorial	Aspen	Hybrid Quantum-Classical Algorithms on Amazon Braket
11:30–13:00	Lunch	Pavillion	Lunch
	Exhibits	Centennial Ballroom	Exhibits
13:00–14:30	Papers	Birch	QSS Control
	Workshop	Interlocken A	Schulz, TU Munich, TU Denmark, Leibniz SC: Integrating HPC with QC
	Tutorial	Ponderosa	IBM Quantum: Software Prototypes of Adv QC Techniques
	Workshop	Interlocken B	Date, Hamilton, Delgado, ORNL: Quantum Artificial Intelligence
	Tutorial	Spruce	Q-CTRL: Quantum Control: Quantum Technology Potential
	Workshop	Pine	Giani, Huang, GE Res & PNNL: QC Renewable Energy & Climate Change
	Tutorial	Fir	QuEra, Pasqal SAS: QC with Neutral Atoms: Intro & Practice
	Tutorial	Alder	Mishar, US Army: Intro to Quantum Comm & Internet

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MT (UTC-6)	Session Type	Session Room	Wednesday Sessions
13:00–14:30	Tutorial	Cedar	TU Delft: QML for Full-Stack Quantum Computation
	Tutorial	Aspen	Hybrid Quantum-Classical Algorithms on Amazon Braket
14:30–15:15	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
	Posters	Interlocken Ballroom CD	Posters

What is Quantum Delta NL?

The Netherlands is a vibrant international hotspot for quantum technology, with leading science, technology and talent. With Quantum Delta NL, we are creating a fully functional national ecosystem for excellence in quantum innovation, for highly talented professionals to bring quantum computers, quantum networks and quantum sensors to the market.

The Netherlands has the vision, technology, talent and partnerships to move to the forefront of this complex field, becoming a dynamic Quantum Delta NL. Successful development and innovative application of quantum technology require us to overcome major scientific and technological challenges and integrate diverse technologies and disciplines, adopting a targeted strategy and approach backed by all parties in the ecosystem. By working together, we can simultaneously lift technology readiness levels across the board.

Affiliated universities and research centres

Our hubs

- Delft - quantum computing, internet & network
- Eindhoven - post-quantum crypto, quantum simulation & materials
- Leiden - applied quantum algorithms
- Twente - quantum electronics & photonics
- Amsterdam - applied quantum algorithms, quantum sensing & simulation

What we do

3 Cat Programmes

Quantum Delta NL is kicking off three ambitious catalyst programmes designed to accelerate the process of introducing quantum technology to the market and to society. The aim is to provide easy access to quantum networks, computers and simulators, lowering the threshold to development and testing. The programmes have a cohesive function, bringing together the various technologies and action lines, various ecosystem actors, and the scientific and user communities.

4 Action lines

Reinforcing the innovation ecosystem. Building mass and excellence in knowledge, talent, infrastructure and enterprise requires new investment and commitment. Besides investing in facilities and hardware, Quantum Delta NL presents four action lines focused on creating the preconditions for success.

MT (UTC-6)	Session Type	Session Room	Wednesday Sessions
15:15–16:45	Papers	Birch	QSS General-1
	Workshop	Interlocken A	Schulz, TU Munich, TU Denmark, Leibniz SC: Integrating HPC with QC
	Tutorial	Ponderosa	IBM Quantum: Software Prototypes of Adv QC Techniques
	Workshop	Interlocken B	Date, Hamilton, Delgado, ORNL: Quantum Artificial Intelligence
	Panel	Spruce	QC & QM: Low-level Progr to Deliver Quantum Advantage
	Workshop	Pine	Giani, Huang, GE Res & PNNL: QC Renewable Energy & Climate Change
	Tutorial	Fir	QuEra, Pasqal SAS: QC with Neutral Atoms: Intro & Practice
	Panel	Alder	Qblox: How to build a secure Quantum Internet
	Tutorial	Cedar	TU Delft: QML for Full-Stack Quantum Computation
	Papers	Aspen	QNC Random Number Generation
16:45–17:30	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
17:30–18:45	Keynote	Interlocken Ballroom AB	Katie Pizzolato, IBM Quantum: Continuous Path Towards Quantum Advantage
18:45–20:30	Reception	Pavillion	Reception with sponsors and exhibitors

Access Online Schedule →

QCE22 Program — Thu, 22 Sept

MT (UTC-6)	Session Type	Session Room	Thursday Sessions
8:00–9:15	Keynote	Interlocken Ballroom AB	Wim van Dam, Microsoft: Azure Quantum and the Road to Scalable Quantum Computing
09:15–10:00	Break		Break
	Exhibits	Centennial Ballroom	Exhibits
	Posters	Interlocken Ballroom CD	Posters

MT (UTC-6)	Session Type	Session Room	Thursday Sessions
10:00–11:30	Papers	Birch	QAA CUBO
	Workshop	Interlocken A	Rosand, IBM Quantum: Design & Simulation of Superconducting Qubits
	Panel	Pine	FNAL, Atlatic Q, LBNL, Zurich: Qubit-specific Control Electronics
	Workshop	Interlocken B	NVIDIA, Unitary Fund, Zapata, Microsoft: QIR Progress & Challenges
	Tutorial	Spruce	Cambridge Quantum: Error-mitigated Algorithms
	Workshop	Ponderosa	Battistel, Qblox, U Melbourne: RT Decoding for Fault-Tolerant QC
	Tutorial	Fir	Agnostiq: Covalent -- Orchestrating QML Workflows
	Tutorial	Alder	ANL: SeQUeNCe: Event Simulator of Quantum Networks
	BoF	Cedar	Acceleration of Quantum Sci & Eng via Metascience
	Papers	Aspen	QNC Characterization
11:30–13:00	Lunch	Pavillion	Lunch
	Exhibits	Centennial Ballroom	Exhibits
13:00–14:30	Papers	Birch	QAA VQE
	Workshop	Interlocken A	Rosand, IBM Quantum: Design & Simulation of Superconducting Qubits
	Tutorial	Pine	IBM Quantum: Qiskit Error Correction Software Framework
	Workshop	Interlocken B	NVIDIA, Unitary Fund, Zapata, Microsoft: QIR Progress & Challenges
	Tutorial	Spruce	Cambridge Quantum: Error-mitigated Algorithms
	Workshop	Ponderosa	Battistel, Qblox, U Melbourne: RT Decoding for Fault-Tolerant QC
	Tutorial	Fir	Agnostiq: Covalent -- Orchestrating QML Workflows
	Tutorial	Alder	ANL: SeQUeNCe: Event Simulator of Quantum Networks

Access Online Schedule →

MT (UTC-6)	Session Type	Session Room	Thursday Sessions
13:00–14:30	Tutorial	Cedar	TU Delft: Benchmarking RL-Based Quantum Compilation
	Papers	Aspen	QNC Entanglement
14:30–15:15	Break		Break
	Posters	Interlocken Ballroom CD	Posters

Access Online Schedule →

MT (UTC-6)	Session Type	Session Room	Thursday Sessions
15:15–16:45	Papers	Birch	QAA General-1
	Workshop	Interlocken A	Rosand, IBM Quantum: Design & Simulation of Superconducting Qubits
	Tutorial	Pine	IBM Quantum: Qiskit Error Correction Software Framework
15:15–16:45	Workshop	Interlocken B	NVIDIA, Unitary Fund, Zapata, Microsoft: QIR Progress & Challenges
	Panel	Spruce	Quantum Machines: Controlling 1000+ Qubits
	Workshop	Ponderosa	Battistel, Qblox, U Melbourne: RT Decoding for Fault-Tolerant QC
	Panel	Fir	IBM, Quantinuum: Being your authentic self: Promoting DEI in QC
	Bof	Alder	IP for Quantum Technology: Commercialization & Patentability
	Tutorial	Cedar	TU Delft: Benchmarking RL-Based Quantum Compilation
	Papers	Aspen	QNC Scheduling
16:45–17:30	Break		Break
17:30–18:45	Keynote	Interlocken Ballroom AB	Tony Uttley, Quantinuum: A Measured Approach to Quantum Computing
18:45–20:30	Banquet	Pavillion	Banquet

QCE22 Program — Fri, 23 Sept

MT (UTC-6)	Session Type	Session Room	Friday Sessions
8:00–9:15	Keynote	Interlocken Ballroom AB	Anna Grassellino, Fermilab | Director, SQMS Center: Superconducting Quantum Materials and Systems (SQMS) – a DOE National Quantum Information Science Research Center
09:15–10:00	Break		Break
10:00–11:30	Papers	Birch	QAA Error Mitigation
	Panel	Pine	OneQuantum: Quantum Computing Startups
	Workshop	Alder	Fahim, Charbon, FNAL EPFL: Cryogenic Electronics for QC
	Workshop	Interlocken A	Shaydulin, Pistoia, JPMorgan: QuAlgorithms Financial Applications
	Tutorial	Ponderosa	IBM Quantum: Error Correction with Quantum Services
	Tutorial	Spruce	Singapore: QuantumFlow+VACSEN: Neural Networks
	Tutorial	Fir	LBNL, Sandia: QC Benchmarks for Algorithms & Error Correction
	Tutorial	Cedar	LBNL: Sythesizing Resource Efficient Quantum Programs
	Papers	Aspen	QSS General-2
11:30–13:00	Lunch	Pavillion	Lunch
13:00–14:30	Papers	Birch	QAA General-2
	Workshop	Alder	Fahim, Charbon, FNAL EPFL: Cryogenic Electronics for QC
	Workshop	Interlocken A	Shaydulin, Pistoia, JPMorgan: QuAlgorithms Financial Applications
	Tutorial	Ponderosa	IBM Quantum: Error Correction with Quantum Services
	Tutorial	Spruce	Singapore: QuantumFlow+VACSEN: Neural Networks
	Tutorial	Fir	LBNL, Sandia: QC Benchmarks for Algorithms & Error Correction

Access Online Schedule →

MT (UTC-6)	Session Type	Session Room	Friday Sessions
13:00–14:30	Tutorial	Cedar	LBNL: Sythesizing Resource Efficient Quantum Programs
	Papers	Aspen	QSS Debugging
14:30–15:15	Break		Break
15:15–16:45	Workshop	Alder	Fahim, Charbon, FNAL EPFL: Cryogenic Electronics for QC
	Workshop	Interlocken A	Shaydulin, Pistoia, JPMorgan: QuAlgorithms Financial Applications

Why IEEE Quantum?

IEEE Quantum is an IEEE Future Directions initiative launched in 2019 that serves as IEEE's leading community for all projects and activities on quantum technologies. The initiative has developed a project plan to address the current landscape of quantum technologies, identify challenges and opportunities, leverage and collaborate with existing initiatives, engage the quantum community at large, and sustain the Quantum Initiative in the long-term.

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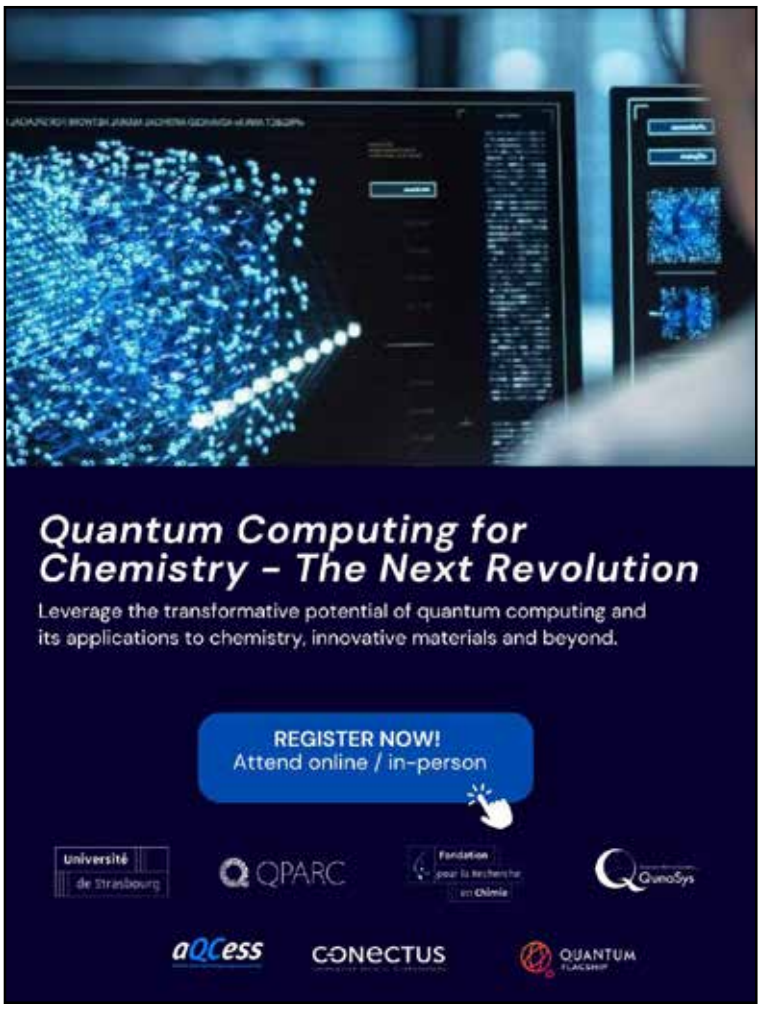

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