Title: Industry Speaker Presentations

Speakers:

Collection: Quantum and AI Career Trajectories Mini-Course: Computational Methods and their Applications

Date: May 11, 2023 - 3:30 PM

URL: https://pirsa.org/23050101

Abstract: Confirmed companies:
1QBit
SandboxAQ
ZebraKet
Nord Quantique
Xanadu
Agnostiq
YiyaniQ
Amazon Web Services

Exploring the Future of Computation

An Introduction to 1QBit

Alexander Neirinckx – May 11, 2023

1QBit

1QBit's Mission

Redefine Intractable

1QBit is developing low-power-consumption devices for quantum computing and artificial intelligence.

Artificial Intelligence

Advanced Computing Innovation

Quantum computing

1QBit

Research at 1QBit

Building on a decade's worth of experience in application development, 1QBit is currently in the process of a strategic expansion:

- Developing quantum and physics-based hardware
- Expanding R&D activities in:

  › **Energy-efficient hardware design for AI**

  ›› **Classical hardware design for FTQC**

  ››› **The development of quantum control and hardware benchmarking software products**

Career opportunities

- **Internships:**
  - Jumpstart your career with 1QBit
  - Mitacs placements
- **Career development:**
  - Mentorship, integration, teamwork
  - Encouraged growth within the company
- **Project assignments:**
  - Flexible team environment
- **Actively hiring for:**
  - FTQC / Quantum optics / Cryo IC design / Device characterization
  - See: 1qbit.com/careers

Life at 1QBit

1QBit has a **distributed workforce** across Canada, with three offices in Waterloo, Vancouver, and Sherbrooke (currently hiring).

Offices			
	Vancouver	Waterloo	Sherbrooke

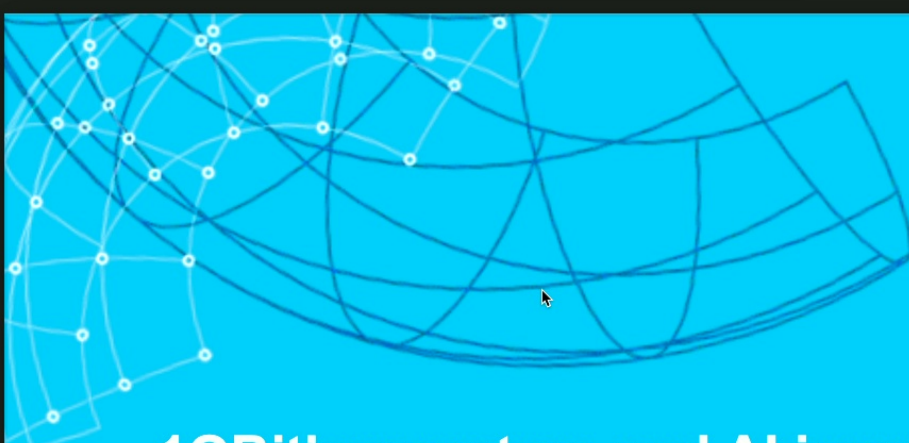| Strategic Partners | QAI QUANTUM ALGORITHMS INSTITUTE | PI PERIMETER INSTITUTE / IQC Institute for Quantum Computing | INSTITUT QUANTIQUE UNIVERSITÉ DE SHERBROOKE / 3IT / Mila |

1QBit

5

1QBit's quantum and AI journey began almost a decade ago, and we're only getting started!

We are always seeking bright, new talent to work with. Feel free to reach out:

alexander.neirinckx@1qbit.com

bohdan.kulchytskyy@1qbit.com

1QBit

agnostiq

Developing Software for the Quantum Era

Agnostiq develops software tools that make quantum and high performance computing resources more accessible to enterprises and developers. Along with its algorithmic research, Agnostiq is developing Covalent, an open source workflow orchestration platform designed to help users manage and execute tasks on heterogeneous compute resources.

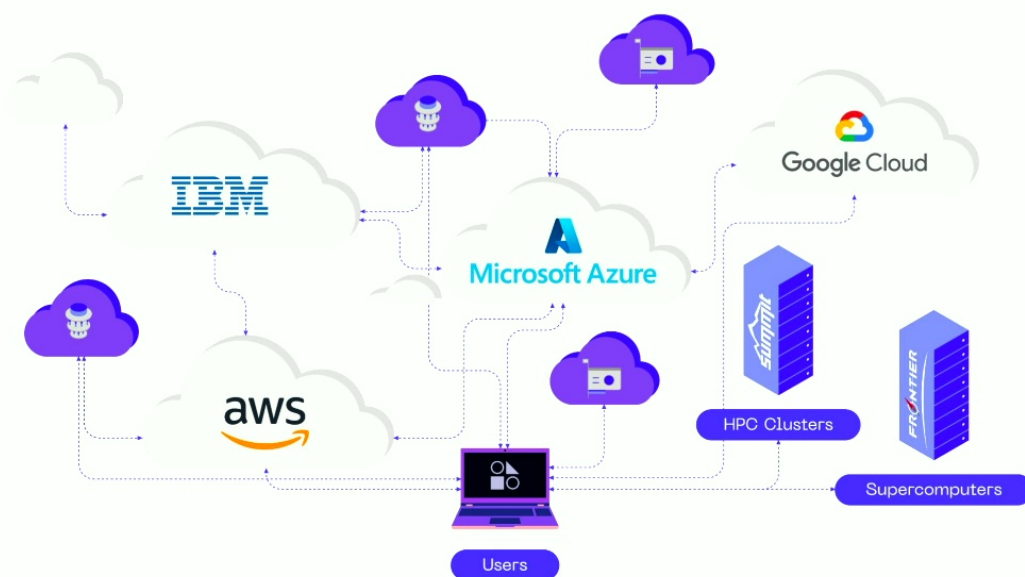HQ in Toronto, Canada   20 FTE

Blog

Documentation

Tutorials

Code

www.agnostiq.ai | contact@agnostiq.ai | www.covalent.xyz

Quantum is driving the need for more heterogeneity.

Quantum workflows use combinations of CPUs, GPUs and QPUs

- Multi cloud technology

- Diversity of resource types (CPUs, GPU arrays, quantum computers)

- Combination of on-prem and cloud resources (multi-cloud)

- On-demand / bursting requirements

- Need to scale up and scale out

- Operational complexity

www.covalent.xyz

Covalent. 2

Covalent is a workflow orchestration platform for heterogeneous computing

Distributed workflow orchestration

Scale workloads from your laptop to any combination of hardware, cloud, or on-premises cluster with a single line of code.

Browser-based GUI

Visualize workflows as DAGs, monitor workflow execution in real-time, and reproduce experiments using Covalent's built-in metadata collection

Heterogeneous hardware & software

Covalent is purpose-built to support workflows that leverage a diverse range of hardware (CPU, GPU, QPU) and software frameworks
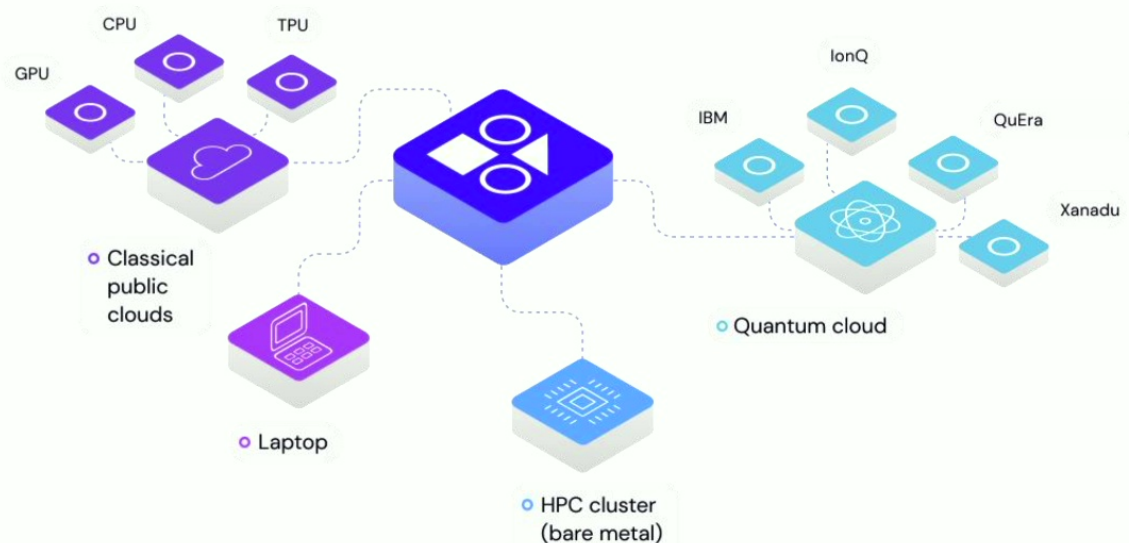
www.covalent.xyz

Covalent 3

Effortlessly prototype, iterate and productionalize computations across any hardware or cloud.

Solutions:

Machine Learning

Rapidly prototype computationally intensive ML models, and seamlessly scale to any hardware or cloud – all from your python environment.

Scientific Computing

Make computational chemistry & materials science workflows more manageable using Covalent's Slurm and C integrations & cloud-bursting capabilities.

Finance

Build, scale and productionalize your computationally heavy applications directly in Python. Take advantage of advanced computing modalities like quantum and other ASICs.

Bio & Life Sciences

Prototype and scale workflows from image analysis to drug discovery across multiple cloud platforms effortlessly from a Jupyter notebook
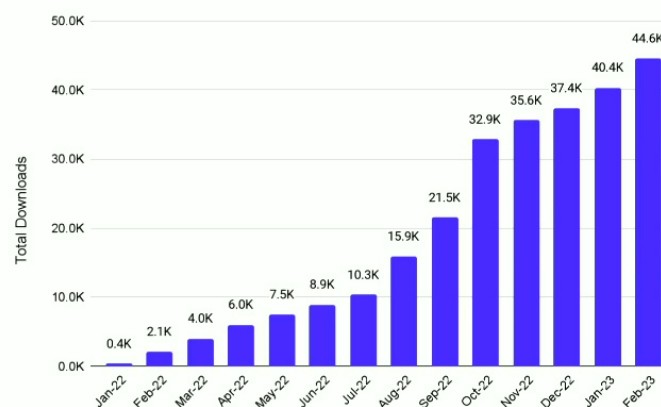
Quantum Computing

Unify and manage your classical on prem/cloud HPC with all major quantum hardware modalities.

Serverless

Supercharge your team's workflows with Covalent's on-demand, serverless quantum hybrid HPC architecture. Only pay for what you use and spend less time waiting in queues.

Covalent has been embraced by the community

Bar chart titled "Total Downloads" with values:
Jan-22: 0.4K, Feb-22: 2.1K, Mar-22: 4.0K, Apr-22: 6.0K, May-22: 7.5K, Jun-22: 8.9K, Jul-22: 10.3K, Aug-22: 15.9K, Sep-22: 21.5K, Oct-22: 32.9K, Nov-22: 35.6K, Dec-22: 37.4K, Jan-23: 40.4K, Feb-23: 44.6K

www.covalent.xyz

Covalent.

Thanks for listening!

covalent.xyz   agnostiqHQ/covalent   @covalentxyz

agnostiq.ai

aws

Quantum Technologies at AWS

Matthew Beach, PhD

Applied Scientist
AWS, Amazon Braket

Quantum Technologies at AWS

AWS Center for Quantum Computing

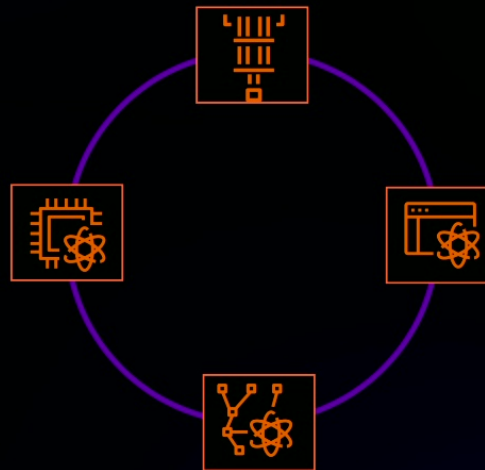Researching and building fault-tolerant quantum computers

Amazon Braket

Providing access to quantum computers through AWS cloud

Amazon Quantum Solutions Lab

Engaging with customers to solve industry problems

AWS Center for Quantum Networking

Researching quantum networks

Additional Information

o Sign up for for an AWS account and get started today at aws.amazon.com/braket

o Apply for AWS Credits for Research program aws.amazon.com/braket/quantum-computing-research/

o Monitor open positions and internships at amazon.jobs

aws

IBM Quantum Computing

Aggie Branczyk
Senior Research Scientist

IBM Quantum

IBM Quantum – On the cloud since May 2016

Over 460,000 registered users have run …

over 2 TRILLION hardware quantum circuits in total, and users run …

over 4 BILLION hardware quantum circuits on a typical day on …

more than 25 quantum computing systems on the IBM Cloud, and written over

1750+ scientific and research papers.

IBM Quantum © 2023 IBM Corporation

IBM **Quantum**
System One
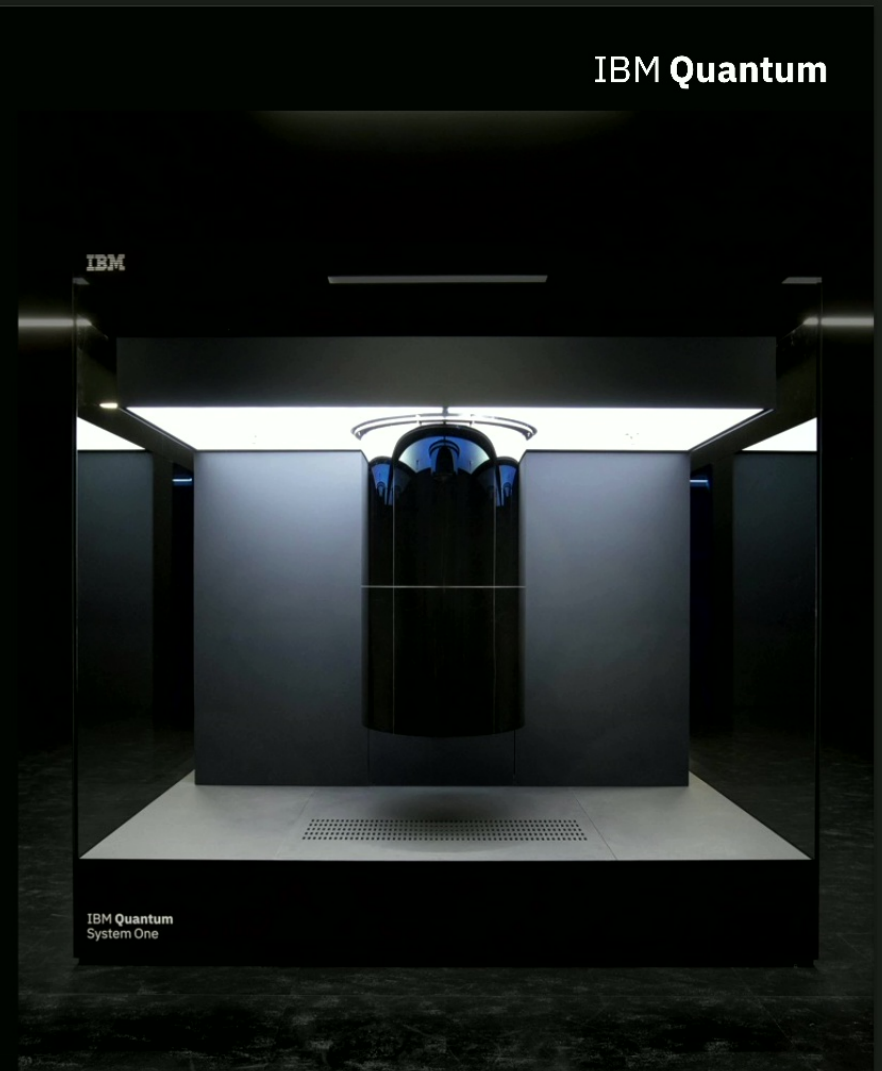
Qiskit – Open-Source SDK

High level applications

- Qiskit Nature
- Qiskit Finance
- Qiskit Optimization
- Qiskit Machine Learning

Low level applications

- Qiskit Metal
- Qiskit Dynamics
- Qiskit Experiments

Core Capabilities

- Qiskit Terra

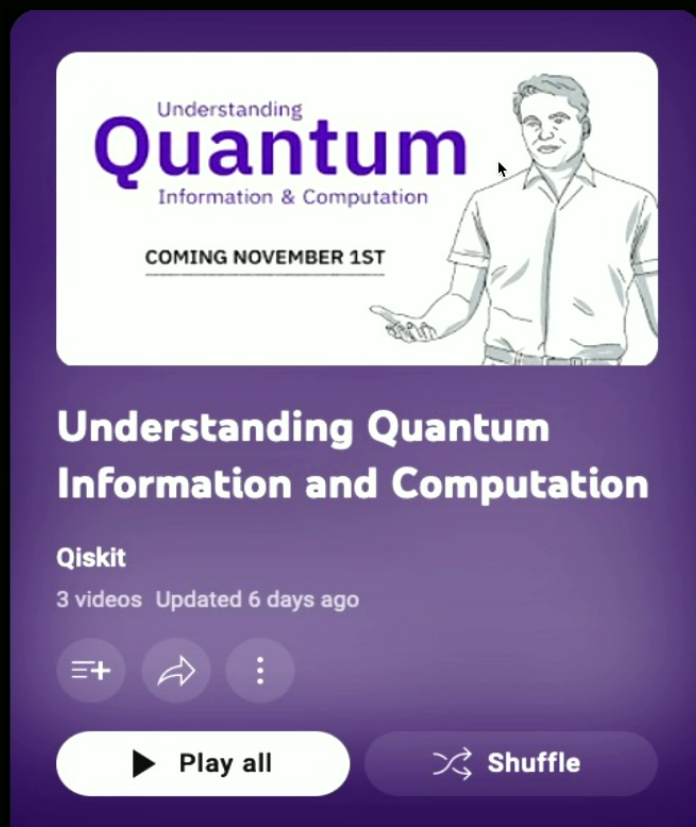**Simulator**

- Qiskit Aer

Hardware providers

- IBM
- AQT
- IonQ
- ...

Educational Resources

https://www.youtube.com/playlist?list=PLOFEBzvs-VvqKKMXX4vbi4EB1uaErFMSO
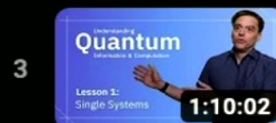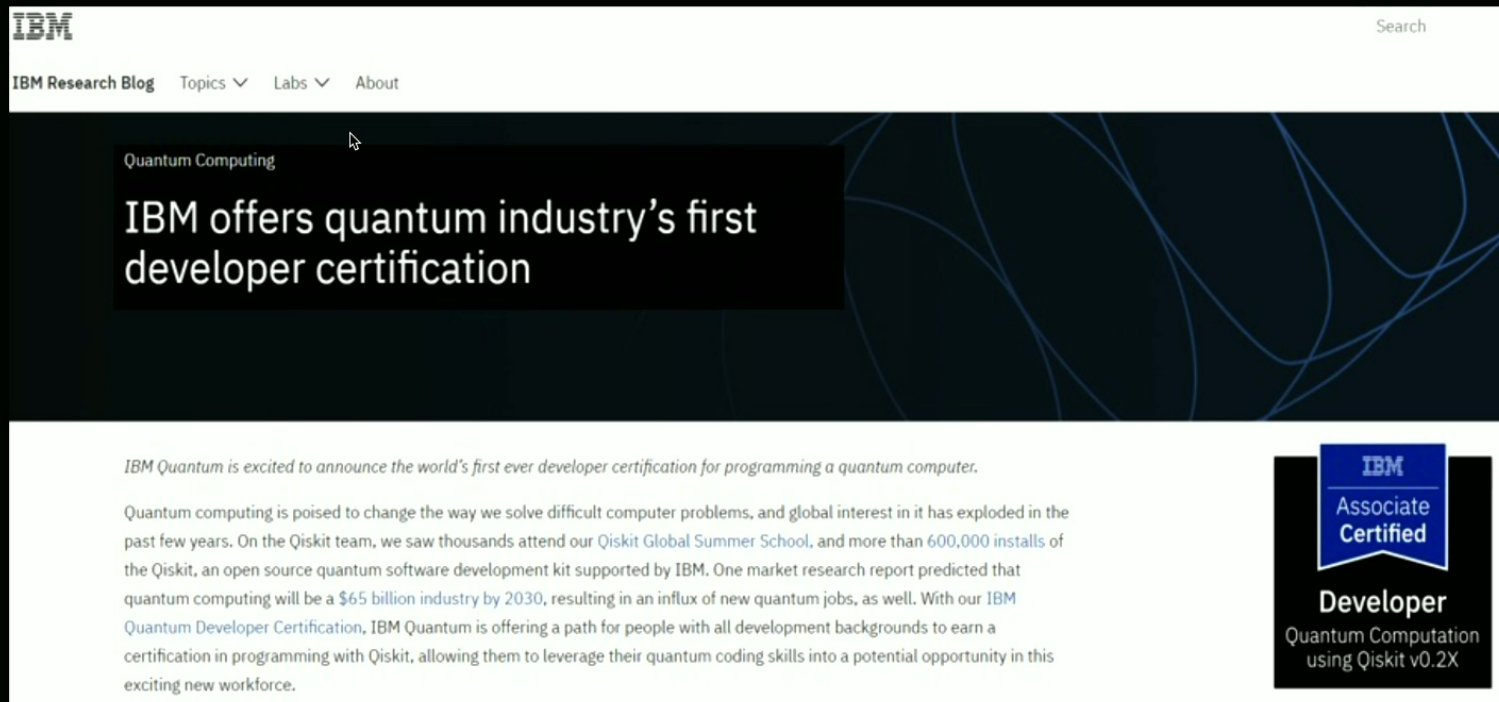
Educational Resources

IBM offers quantum industry's first developer certification

IBM Quantum is excited to announce the world's first ever developer certification for programming a quantum computer.

Quantum computing is poised to change the way we solve difficult computer problems, and global interest in it has exploded in the past few years. On the Qiskit team, we saw thousands attend our Qiskit Global Summer School, and more than 600,000 installs of the Qiskit, an open source quantum software development kit supported by IBM. One market research report predicted that quantum computing will be a $65 billion industry by 2030, resulting in an influx of new quantum jobs, as well. With our IBM Quantum Developer Certification, IBM Quantum is offering a path for people with all development backgrounds to earn a certification in programming with Qiskit, allowing them to leverage their quantum coding skills into a potential opportunity in this exciting new workforce.

ibm.co/quantumdevcert

Job opportunities

IBM Quantum

Research
Research Scientist – Quantum

Experience: Professional
Location: Hursley, GB

→

Project Management
Quantum Project Manager

Experience: Professional
Location: Multiple Cities

→

Research
Senior Research Scientist – Quantum

Experience: Professional
Location: Hursley, GB

→

Enterprise Operations
IBM Quantum Product Marketing Manager

Experience: Professional
Location: Multiple Cities

→

Project Management
IBM Quantum Engagement Manager (Europe)

Experience: Professional
Location: Multiple Cities

→

Enterprise Operations
Sr. Product Marketing Manager-Quantum Safe

Experience: Professional
Location: Multiple Cities

→

Software Engineering
Quantum Dev Ops Engineer

Experience: Professional
Location: Multiple Cities

→

Software Engineering
Enabling Quantum Tech Applications Researcher

Experience: Professional
Location: Yorktown Heights, US

→

Project Management
Quantum Client Delivery Lead Korea

Experience: Professional
Location: Seoul, KR

→

Cloud
BlueCamp Internship Program: Developer for Quantum Community

Experience: Intern
Location: Multiple Cities

→

Infrastructure & Technology
Quantum System Integration Lead (Ykt Heights or Poughkeepsie, NY)

Experience: Professional
Location: Multiple Cities

→

https://www.ibm.com/careers

IBM Quantum © 2023 IBM Corporation

Florian Hopfmueller, PhD

Theoretical Quantum Physicist

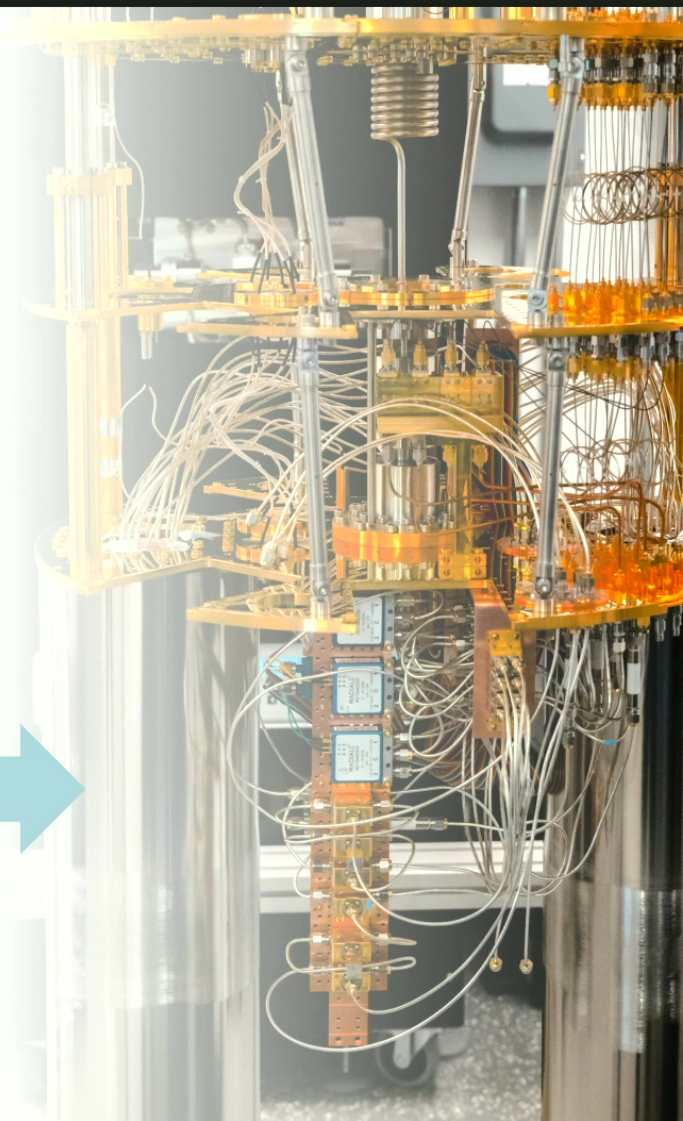| 2016-2021:	2019-2022:	2022-:
PhD @ PI	**1QBit**	**Nord Quantique**
Gravity & Quantum Gravity	Machine Learning & Quantum Control	Designing quantum devices & QEC

Materialize
Error-corrected
Quantum Computing

Founded in January 2020

Sherbrooke, Quebec

20 people

Seed stage, $12.7 M$ funding

Quantum Hardware Company

Built-in error correction (GKP)

Field pioneers advisors

Prof. Michel Devoret (Yale)
Prof. Alexandre Blais (U Sherbrooke)
Prof. Baptiste Royer (U Sherbrooke)

Theory team:
control & simulation; error correction; software

Nord Quantique

www.nordquantique.ca

Florian Hopfmueller

florian@nordquantique.ca

fhopfmueller.me

ABOUT QUANTUM VALLEY IDEAS LABORATORIES

Canada's Quantum Valley

Quantum Valley Ideas Laboratories (QVIL)

Quantum Valley Investments • Research Acceleration Centre • Quantum Valley Ideas Lab • Institute for Quantum Computing • Quantum NanoFab • Lazaridis Institute for Management of Technology Enterprises • Perimeter Institute of Theoretical Physics

Federal Economic Development Agency for Southern Ontario
Agence fédérale de développement économique pour le Sud de l'Ontario

- Independent, non-profit industrial research lab

- Mission: accelerate the commercialization of quantum technologies

- Application driven research with proficiency in Quantum Sensing, MEMS, Vapour Cells, Quantum Optics

- Growing 30 person team (20+ PhDs); more than 30 patents filed in 4 years

- Recognized as a global leader in Rydberg Atom radio frequency (RF) quantum sensing applications

- Funded by the Canadian Government and private donors; additional funding from Canadian National Research Council, and Department of National Defence; also from US Department of Defense via DARPA

- Developing a global ecosystem of research, commercial and strategic partners that support our mission.

QVIL AS A HUB IN THE QUANTUM RF SENSING ECOSYSTEM

QVIL VISION– COMMERCIALIZATION OF QUANTUM TECHNOLOGY

- Industrial research laboratories in the period of 1920–1970 led to what is widely believed to be the most innovative age of man

- These institutions had a mandate to innovate and access to pressing 'problems'

- Naturally multidisciplinary

- Focus on delivering value, profitability through innovation as the only important metric

GE

Bell Laboratories

Xerox Parc

RCA Laboratories

IBM – Almaden

Menlo Park

Quantum Valley
Ideas Lab
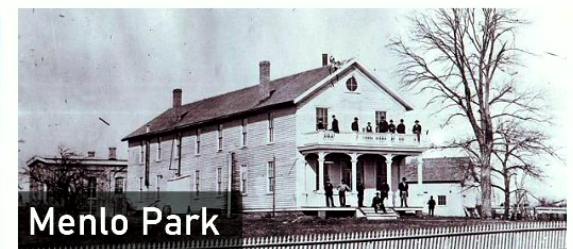
Quantum Valley Ideas Lab

What is Xanadu?

Mission: "To build quantum computers that are useful and available to people everywhere"

Software:
How to program a quantum computer?

Hardware:
How to build a quantum computer?

PennyLane

Device-agnostic Python library used to run quantum circuit in the most powerful quantum devices.

Useful for:

- Researchers
- Students
- Lecturers
- Anyone wishing to learn quantum computing

Skills needed for all teams

Knowledge of Quantum: At the levels of a Master's Degree that includes a Quantum Theory and Quantum Computing/Information course. At least one Quantum Software Framework (PennyLane, Qiskit, Cirq)

Software development: Backend, version control, best practices. (Python, Git, are a MUST)

Scientific Communication: Simplifying concepts, education

Research: Keeping up to date, identifying viable research directions, writing scientific articles

Project Management: Tasks, timelines, leadership, delegation

Problems solving: Both scientific and non-scientific.

Core Team

Role: "Create, develop and maintain PennyLane functionalities"

Knowledge of Quantum ★ ★ ★

Software development ★ ★ ★ ★ ★

Scientific Communication ★ ★

Research ★ ★

Project Management ★ ★ ★

Problem Solving ★ ★ ★ ★

Additional Skills:

- Collaborative Work
- Reviewing and Debugging

Keep an eye on our Careers webpage!

https://xanadu.applytojob.com/apply

Keep an eye on our Careers webpage!

https://xanadu.applytojob.com/apply

Market Challenges

Current models ignore the interrelationships within supply chain elements

Companies are struggling to measure their supplier carbon footprint

Hidden cost of downtime

- Unplanned downtime is estimated at $50 billion each year
- A company's single day's disruption cost was $275,000 resulting in a shareholder loss of $6M
- Global greenhouse gas (GHG) emissions will need to drop by nearly half by 2030

Use-Case 1: Inventory Optimization in a Complex Supply Chain Network
— Problem Definition: Procurement Process Automation/Digitization

Minimize:
Holding Costs (Warehouse costs)
+ Ordering Costs (Order frequency)
+ Purchasing Costs (quantity discount)
+Transportation Costs
+ Supplier Carbon Footprint

Optimizng:
Supplier selection
Order quantity and frequency

Interrelationships:
Bundling discounts
Historic order risk
Purchasing behavior
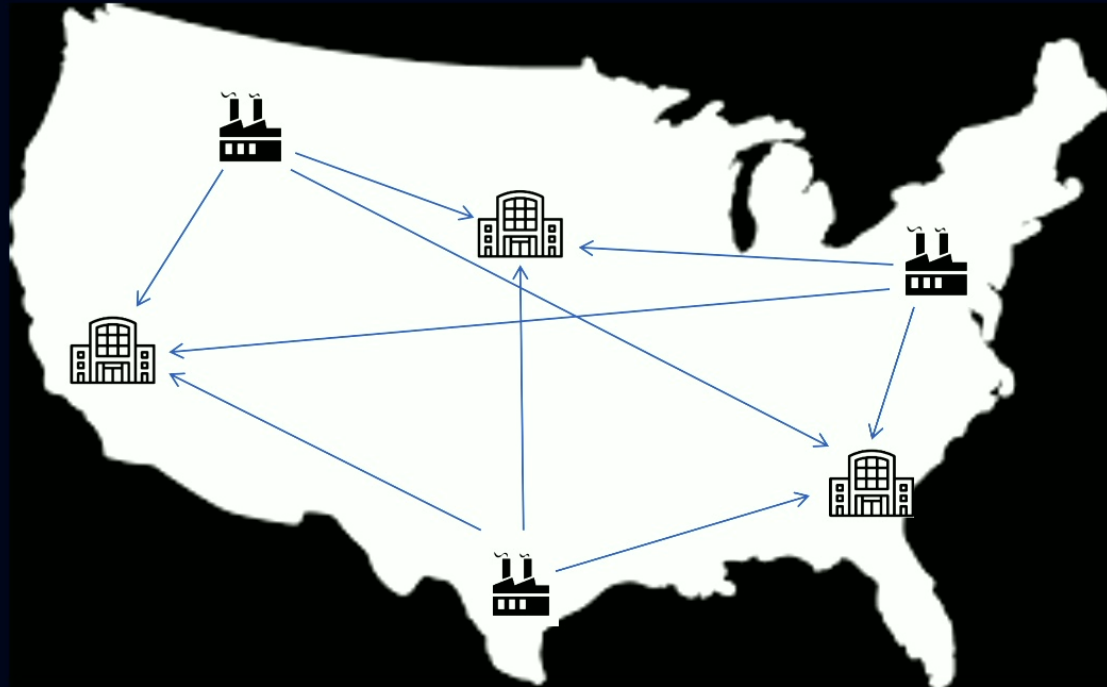
Use-Case 1: Inventory Optimization in a Complex Supply Chain Network

— Benchmark

Trial	Retailers	Product	Suppliers
0	10	45	4
1	6	55	8
2	4	73	10
3	4	96	6
4	4	104	5
5	3	151	4

Interrelationships:
Bundling discounts
Historic order risk
Purchasing behavior

MEIO Benchmark D-Wave and Classical

- Classical
- D-Wave Hybrid CQM

Tipping point

time to solution (sec)

trial #
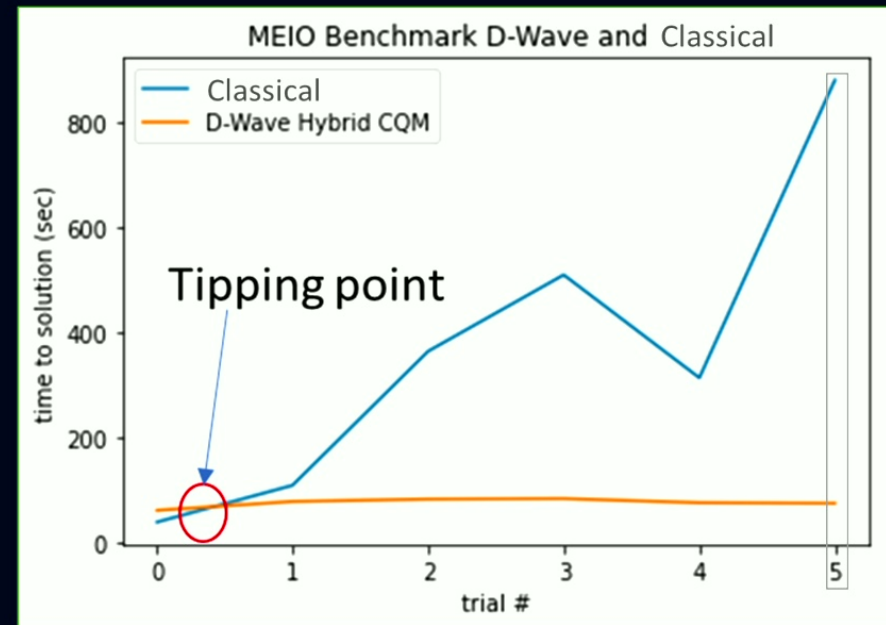
Use-Case 2: GHG Measurement Optimization

Facility complexity

Measurement complexity

Sensor|Camera Placement Optimization
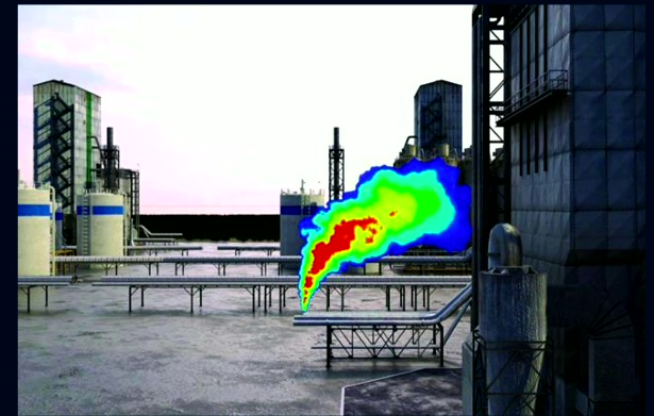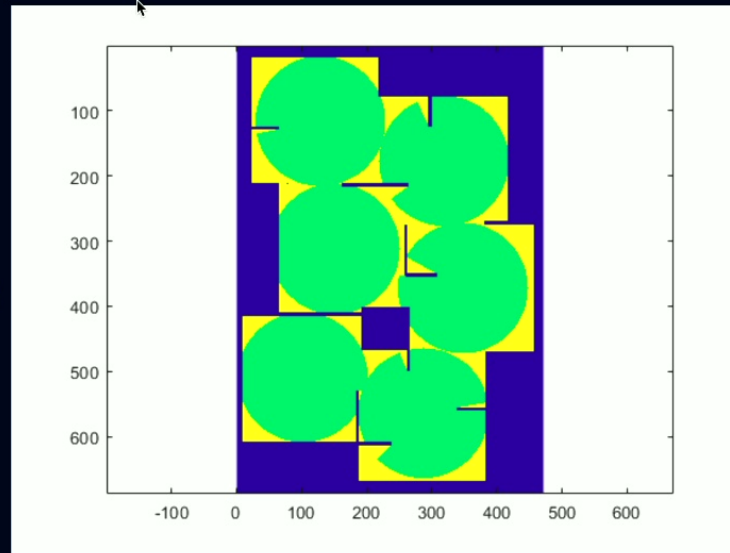
Making supply chain companies more resilient and sustainable using quantum computing and artificial intelligence

Contact

Locations:
Toronto, Canada
Baltimore, USA

Email:
Alex.khan@zebraket.com
Ehsan.torabizadeh@zebraket.com

SandboxAQ

AI and Quantum Tech

We solve large-scale enterprise challenges using the best of today's physics & AI platforms

Quantum physics allows new data to be collected and processed

Advanced AI is required to take advantage of the new data

Physics, World of atoms

Artificial Intelligence World of Bits

SANDBOX**AQ**™

SandboxAQ Spinout - March 22, 2022
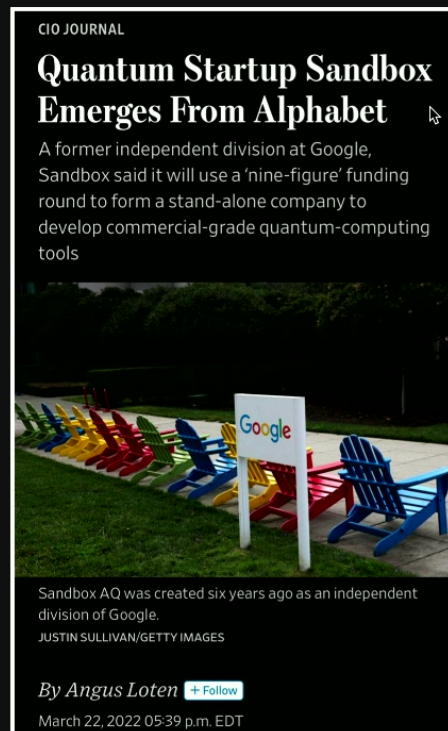
Wall Street Journal

Tech Crunch
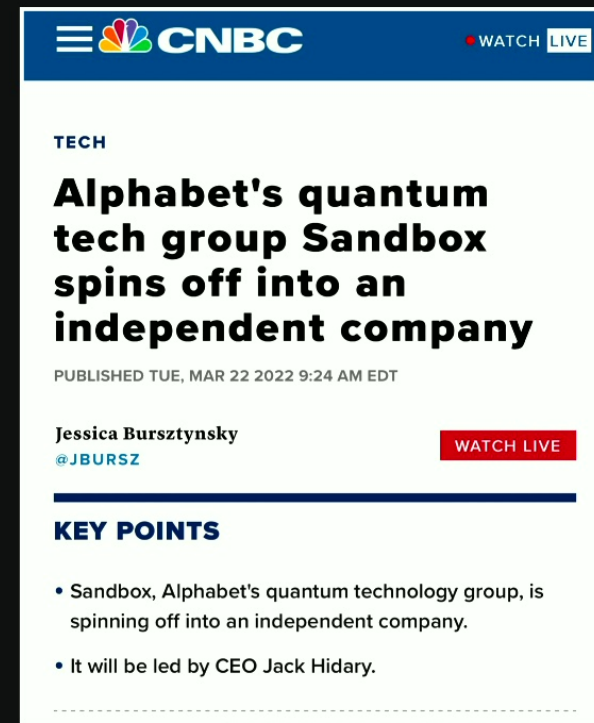
CNBC

Backed by Industry Leaders

Eric Schmidt
SandboxAQ Chairman

Marc Benioff

Thomas Tull

Jim Breyer

David Siegel

T. Rowe Price
INVEST WITH CONFIDENCE

iqt IN-Q-TEL

SUMMIT NORTH

PARKWAY

elaia

SECTION 32

GUGGENHEIM

NATIONAL SECURITY STRATEGIC Investment Fund
Delivered by British Business Bank

Amadeus
Capital Partners

PALADIN
CAPITAL GROUP

QUANTUM
TECHNOLOGY
INVESTORS

SandboxAQ Proprietary Material

SANDBOXAQ™

The rise of quantum computation poses an unprecedented threat for cybersecurity

Alice — Plaintext — Encryption — Bob's **public** key — Ciphertext — Decryption — Bob's **private** key — Plaintext — Bob
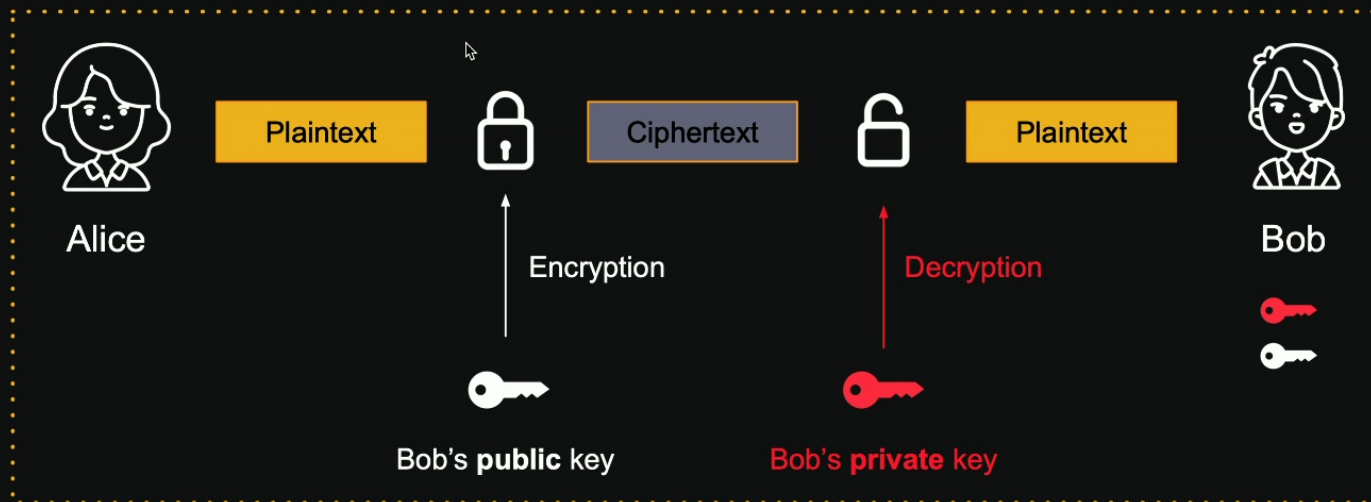
Today's RSA security is based on hard problems to solve for *classical computers*, but ones that are *easy* for quantum computers

In 1994, mathematician **Peter Shor** delineated an algorithm that could solve the problems that today's cryptographic systems rely on.

These include **RSA, Elliptic Curve**, and other widely used cryptographic protocols.

SANDBOX**AQ**™

Cryptography management for all companies includes much more than just PQC

Overall Cryptography Management for Enterprises

Migration to Post Quantum Cryptography (PQC)

SandboxAQ Proprietary Material

SANDBOXAQ™

SandboxAQ Quantum Sensing

Delivering breakthrough solutions for medical diagnostics and global navigation

Enterprise Problem

Quantum sensors enable greater sensitivities than previous generation sensors. However, they cannot be fully exploited by enterprises today due to engineering and noise challenges that come with such sensitivity

Solution

We use the latest generation of quantum sensors, engineered for globally relevant dual-use applications such as medical imaging and quantum navigation, and deploy them alongside AI to allow the signal to be utilized immediately without the need for cryogenics or shielding

SANDBOX**AQ**™

We address two problems

1

The target-to-IND journey is slow and error-prone.

**Faster, more accurate predictions.
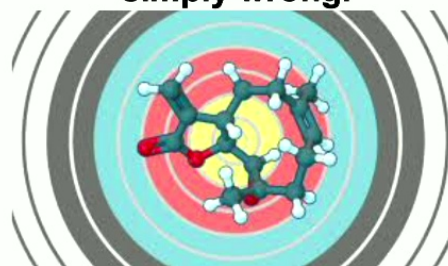Multi-objective optimization. Better leads sooner.**

2

Most therapeutic hypotheses are simply wrong.

- Focus on validated targets that address causal human biology
- **Create predictive lab assays and clinical biomarkers**

In-silico assays adapted to the hypothesis, measuring the effect of the intervention.

SANDBOX AQ™

SandboxAQ Residency Program

For PhD students, post-docs and other relevant students who wish to gain training and hands-on experience in AI and Quantum Tech

SandboxAQ is a place where the brightest, free-thinking minds from across disciplines come together to build technologies at the intersection of artificial intelligence and quantum technologies.

It is essential we have a diverse range of voices involved in building responsible technologies that impact a lot of people. We depend on each other to cancel out our confirmation biases and cultivate an environment that values innovative, open collaboration.

We are currently looking for students with an interest in - AI/ML, biochemistry, biomedical engineering, bioinformatics, biotechnology, cardiology, chemistry, computational biology/chemistry, computer science, data security, diagnostic imaging, mathematics/statistics, medical devices, neuroscience, pharmacology, or physics - to join our team of engineers, scientists and technologists.

Location: Remote   **Start Date: Year-round on a rolling basis**   **Duration: 3-12 months**

SANDBOXAQ™

SandboxAQ Residency Program

Projects for SandboxAQ Residents are generally defined collaboratively with our scientists and engineers, but they can span the following areas:

Quantum Simulation & Optimization

Combine advanced physics-based algorithms with accelerated hardware of today to solve challenging problems to reduce cost and develop new drugs and targets.

Quantum Security

Improve the security of global data infrastructures against imminent quantum attacks due to Shor's algorithm. Migrate from public-key cryptosystems to quantum-resistant cryptosystems, enabling the protection of sensitive health information and intellectual property.

Learning Science + Education

Support our network of educators to create content on quantum information sciences as applied to machine learning, healthcare, and other life sciences disciplines.

Quantum Sensing

Build the next generation of sensors to better understand and design the atomic structures around us. Scale quantum sensing platforms combined with AI to extend the fundamental limits of medical imaging.

Artificial Intelligence

AI techniques (Computer vision, NLP, and others) serve a transformational role across the life sciences - helping to deliver the right encryption at the right time, intelligently denoise medical sensor data to classify diagnostic information, and accelerate the design process for drug discovery, ultimately bringing benefits to patients and payers alike.

Output from a residency may include academic publications, software contributions, technical reports, etc.

SANDBOX**AQ**™

Perimeter Institute Quantum Industry Networking Event
May 11, 2023

	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Session 7	Session 8
Group sessions:	Nord Quantique	1QBit	Agnostiq	Agnostiq	1QBit	Agnostiq	1QBit	AWS
	SandboxAQ	QVIL	QVIL	AWS	IBM Quantum	SandboxAQ	AWS	IBM Quantum
	YiyaniQ	Xanadu	SandboxAQ	IBM Quantum	Nord Quantique	Xanadu	Nord Quantique	QVIL
	ZebraKet	ZebraKet	YiyaniQ		ZebraKet	YiyaniQ		Xanadu

One-on-one meetings:

	Session 1	Session 2	Session 3	Session 4	Session 5	Session 6	Session 7	Session 8
Ali SaraerToosi	AWS				Agnostiq			
Parth Padia	IBM Quantum				Xanadu			
Yushao Chen	1QBit				QVIL			
Faith Oyedemi	Agnostiq				AWS			
Artem Zhutov	Xanadu				SandboxAQ			
Viktoriia Voloshyna	QVIL				YiyaniQ			
Meenu Kumari		SandboxAQ			QVIL			
Matheus Hostert		IBM Quantum			AWS			
Alev Orfi		Agnostiq			Nord Quantique			
Daniel Egaña-Ugrinovic		Nord Quantique			IBM Quantum			
Serge Adonsou		YiyaniQ			ZebraKet			
Anna Knörr		AWS			1QBit			
Evan Peters			1QBit				Xanadu	
Joan Arrow			IBM Quantum				YiyaniQ	
Mary Letey			AWS				Agnostiq	
Jonathon Kambulow			ZebraKet				SandboxAQ	
Katherine Slattery			Nord Quantique				IBM Quantum	
Hlér Kristjánsson			Xanadu				QVIL	
Jacob Barnett				YiyaniQ			ZebraKet	
Wirawat Kokaew				Xanadu				SandboxAQ
Ruozhen Gong				QVIL				ZebraKet
Tejas Naik				Nord Quantique				YiyaniQ
Abdellah Azdoud				1QBit				Agnostiq
Prathamesh Tamhane				ZebraKet				1QBit
Ali Mahmoud				SandboxAQ				Nord Quantique