Q1 2026

IBM **Quantum**

The Coherence Times

A
Quarterly
Readout

Realizing Feynman’s dream

Our quarterly leadership update

A Note from Jay

Hi all, and welcome to the Q1 2026 edition of the Coherence Times: *Realizing Feynman's dream*.

For as long as IBM has pursued quantum computing, we've been motivated by a vision first proposed by famed physicist Richard Feynman in 1981: "Nature isn't classical, dammit, and if you want to make a simulation of nature, you'd better make it quantum mechanical, and by golly it's a wonderful problem, because it doesn't look so easy." Fully realized, a quantum computer should innately outperform a classical-only computer for simulating quantum things.

Forty-five years later, we're seeing a sea change as quantum moves beyond interesting explorations and begins to embody Feynman's vision.

On the one hand, the quantum community is hard at work proving that today's quantum computers serve the role of the tool described by Feynman. They're searching for quantum advantages, or demonstrations that quantum can verifiably outperform all classical-only methods for certain problems. Teams worldwide are submitting advantage experiments to a community-run quantum advantage tracker so that we can track candidates, which the classical community then pressure tests.

Meanwhile, experiments with our clients and partners at Cleveland Clinic, RIKEN, BasQ, Oxford, and ORNL show quantum emerging as a simulation tool augmenting the world's leading classical computational chemistry methods. Today, we're making calculations of relevance and simulating things physicists care about that are approaching provable advantage. And the current trajectory shows that for complex-enough molecules, quantum will soon surpass classical-only techniques. Just recently, IBM released a quantum-centric supercomputing reference architecture showing other organizations how to pull in quantum computing as a resource alongside classical supercomputing to realize similar demonstrations on their own.

We continue to progress along our development roadmap to release a fault-tolerant quantum computer by 2029. This system will unlock a new set of algorithms and greatly expand quantum's potential—but it's critical that users begin their quantum journey before then, as this system's initial use cases will likely focus on extending the workflows developed over the next three years.

We're maturing our product and offerings so that businesses, research institutions, and governments can continue pushing the field. Updates to Nighthawk, Qiskit, and our access plans will let you keep up with the field's incredible progress. We're glad to have you with us.

A reference architecture for QCSC

IBM is publishing a reference architecture for quantum-centric supercomputing, illuminating how HPC centers can integrate quantum into their existing workflows. Motivating this announcement are a host of new results from IBM and partners at Cleveland Clinic, RIKEN, the University of Chicago, and more, demonstrating quantum augmenting HPC in tackling science problems of interest to chemists and physicists.

In short, you can do cutting-edge chemistry with quantum computing provided you can access real quantum hardware and open software as part of a QCSC workflow. IBM is the expert on the hardware, software, and orchestrating that workflow.

On March 12, we announced a technical paper on the arXiv preprint server detailing the reference architecture. This document is a blueprint and schematic for computation centers, showing how and where quantum hardware and software fit into their existing workflows so that they can begin to run QCSC demonstrations like those shown in our proof points. It also projects how quantum and HPC will continue to scale together.

- **Applications:** Scientists develop applications that incorporate both quantum and classical libraries, supporting workflows like simulation, optimization, or solving differential equations. This layer maps problems to appropriate data structures including tensors and quantum circuits, the core units of computation.

- **Application middleware:** In turn, the middleware layer prepares these structures to run on the appropriate hardware, where tools like OpenMP, MPI, and SHMEM prepare data to process on CPUs using Python, C, and C++, and GPUs using CUDA, Triton, and PyTorch, while quantum SDKs like Qiskit, TKET, and CirQ prepare circuits to run on QPUs.

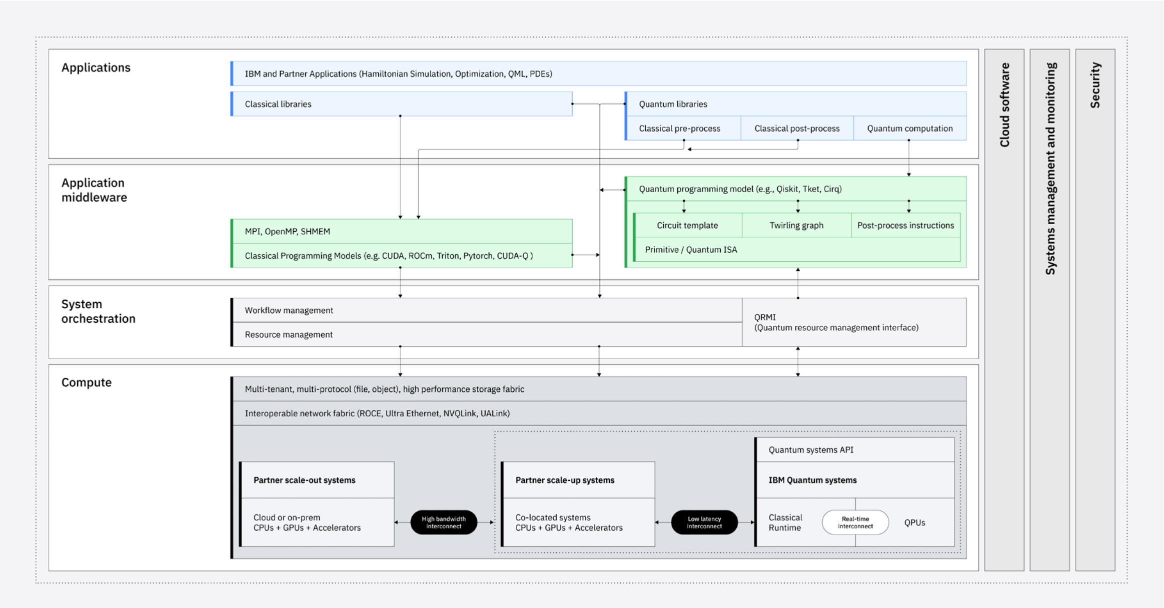
- **System orchestration:** The next layer performs orchestration and allocates resources across the appropriate hardware. The quantum resource management interface (QRMI) is one such open tool, a vendor-agnostic library for HPC systems to access, control, and monitor the behavior of quantum computational resources.

A reference architecture for QCSC

- **Hardware:** Specific categories guide the orchestration at this lowest layer, incorporating QPUs and interconnects to scale-up and scale-out systems of CPUs and GPUs. For example, quantum diagonalization algorithms require scale-out and closed loops, yielding temporal and spatial coupling considerations. Meanwhile, error mitigation requires high-throughput CPU and GPU resources, while users exploring error correction need low-latency classical systems more closely integrated.

IBM's QCSC reference architecture provides a path for accelerating the adoption of quantum computers for solving some of the most complex computational problems. With this pragmatic framework for transitioning today's quantum-classical co-processor model to a tightly integrated QCSC system, HPC centers can use this architecture as a composable and easy-to-adopt roadmap for beginning to address the technical challenges, infrastructure requirements, and platform capabilities that are key to realizing the transformative potential of quantum-centric supercomputing.

By engaging with the reference architecture, data centers can maximize the value of integrating real quantum hardware by co-designing systems for high-impact applications and establishing a foundation that will scale to fault tolerance.



The IBM reference architecture for quantum-centric supercomputing

Quantum Advantage Tracker

A genuine race is emerging between today's leading quantum and classical methods—not behind closed doors, but in full view of the research community.

This contest is taking place on the Quantum Advantage Tracker, a first-of-its-kind, open community effort established to help researchers monitor promising candidates for quantum advantage and systematically evaluate how they stack up against leading classical-only methods.

The tracker was built on the idea that no single researcher or organization can expect to achieve quantum advantage in a vacuum. Instead, it will emerge as an iterative, community-driven exchange. Quantum delivers a result, the classical community responds, quantum hardware improves, and the bar moves again.

Now, just a few months after its launch, something remarkable is happening. The quantum and classical communities' leading research organizations and brightest minds are throwing their hats into the ring, engaging in a spirited back-and-forth that will help shape the future of computation. Let's look at a few recent examples:

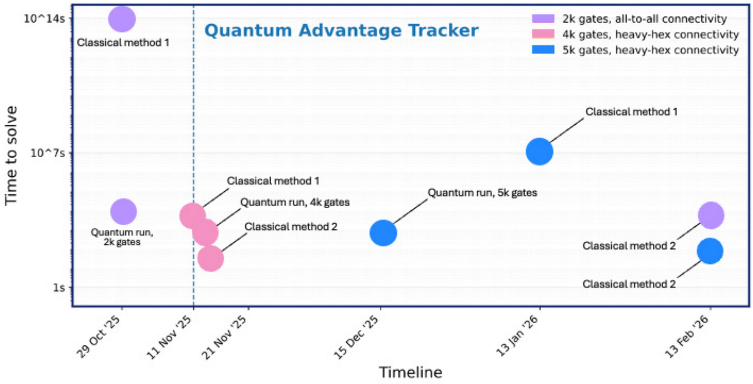
- **BlueQubit tests peaked circuits for advantage**
  Quantum startup BlueQubit has spent the past few months delivering a perfect illustration of the race between quantum and classical methods through their submissions to the advantage tracker, a story we recently covered on the IBM Quantum blog. Their early quantum results outpaced classical methods, prompting iterative testing as new classical algorithms caught up. View the submissions here.

- **University of Wisconsin–Madison challenges quantum chemistry results**
  After IBM researchers submitted quantum estimates for the Fe_4S_4 molecule to the tracker, University of Wisconsin–Madison researchers responded with a classical Trimmed CI method that achieved lower energies, illustrating the competitive back-and-forth on the platform. View the submissions here.

One of the most powerful things about the tracker is how it is encouraging participation from across the community—startups, academic research groups, national labs, and industry researchers all coming together to explore the limits of classical techniques and the potential of quantum alternatives. This isn't an IBM initiative. It's a public, open-source platform created to benefit the entire field.

The Quantum Advantage Tracker welcomes every researcher, organization, and hardware team ready to test ideas, challenge assumptions, and push the fundamental limits of computation. By submitting your work, you join a growing community that is building the future of the field on data, not hype.

Quantum Advantage Tracker



Plot showing a back-and-forth between quantum and classical methods on the way to advantage. Initial results showed quantum far outpacing classical for BlueQubit's peaked circuits problem, prompting development of a new classical method with a much better runtime.

Are you exploring a promising quantum method? Is your team pushing classical techniques further than you ever expected? Add your latest results today and help chart the path to trusted, verified advantage.

Hardware updates: Loon and Nighthawk

The first IBM Quantum Nighthawk processor, ibm_miami, is now available as an exploratory, early-access preview via our Premium and Flex Plans.

Nighthawk is our most advanced quantum processor yet, with a square-lattice topology designed to reduce circuit depths and support the scale and complexity needed for early demonstrations of quantum advantage in 2026. It offers 120 qubits linked together by 218 tunable couplers, compared to IBM Quantum Heron's 176 couplers, and delivers the highest coherence times of any IBM quantum processor ever, with a median of ~350 microseconds. Like Heron, this first generation can reliably execute 5,000 two-qubit gates in a single circuit, an important milestone on the IBM Quantum Roadmap.

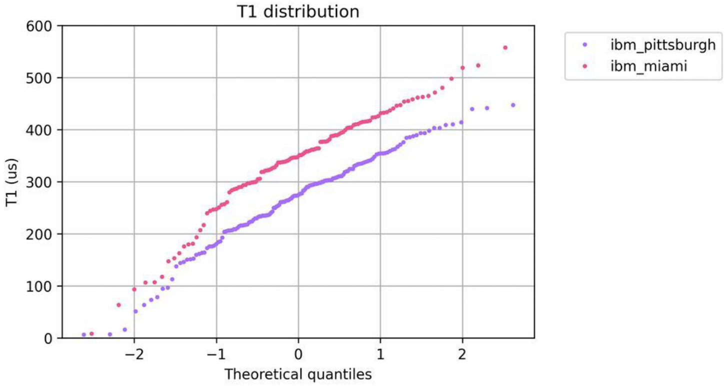
Throughout Q1 2026, our teams have been putting both Nighthawk and the experimental IBM Quantum Loon platforms through their paces, a process that inevitably reveals the quirks and unexpected behaviors of a new architecture. These early passes teach us how the system behaves under real workloads, what needs refinement, and whether the underlying design choices are sound.

For Nighthawk, early runs surfaced considerations that only appear once qubits, couplers, and control lines are all live and interacting at scale. The team quickly found the root causes and fixes are already incorporated into the next device(s). New Nighthawks are cooling or are beginning tests as of this writing, and we expect them to reflect those corrections. Even in the initial Nighthawk model, we're seeing coherence times that exceed what we achieved with Heron, a promising sign that the improvements baked into the design are doing what they're meant to do.

"The important thing is how quickly we converged on the underlying issues as a team. That's how we keep momentum," said Senior Manager of System Deployment and Preproduction David McKay.

Loon followed a similar pattern. Upon testing at cyrogenic temperature, the first device revealed issues that the team now understands and has addressed the causes. The next batch will soon land, and in the meantime we continue testing various aspects of Loon. A first glimpse reveals pairs of test qubits outside the Loon lattice but on the same chip: the c-coupler behaved as expected, and the hardware-native reset operated correctly, with gate performance landing where we'd expect given the design and processing.

"One of the issues genuinely surprised us. But if we're never surprised, we're never learning," said IBM Fellow and VP for Quantum Processors Matthias Steffen.



T1 times for ibm_pittsburgh and ibm_miami in microseconds. These plots are read as distributions, where 0 on the x-axis is the median. ibm_pittsburgh is a Heron R3, ibm_miami is our new Nighthawk.

A new opportunity for Open Plan users

Since first putting a quantum computer on the cloud, IBM has committed to making our hardware accessible to the quantum computing community. Ten years later, we still offer open access to the world's leading quantum computers. But today, we're excited to offer a promotion that expands access for those who spend more time to experiment and build with our systems.

Our open plan will continue to allocate users 10 free minutes of access to real quantum hardware each month on sign-up. But those who use 20 minutes this year can opt into a one-time allocation of 180 free minutes over 12 months. These minutes expire at the end of the 12-month period, and afterward default back to 10 minutes per month. This offer is designed for experienced users to perform deeper explorations, preparing them for further engagement with our pay-as-you-go, flex, and premium plans. We'll also be offering access to the high-performing, 156-qubit Heron r2 chip ibm_kingston.

10 minutes per month offers developers enough runtime to learn, test, and understand quantum workflows—that means running small circuits, executing Qiskit tutorials, implementing basic algorithms, and exploring quantum-classical workflows. 180 free minutes at once lets users run larger and more circuits—that could mean validating a structured quantum proof-of-concept, running iterative algorithm tuning, testing hybrid optimization workflows, benchmarking error mitigation, and even starting to explore domain-specific use cases.

We expect this update to benefit a wide variety of users. Extended access allows the quantum-curious to learn on larger circuits and gain important hands-on experience to validate their ideas. Students and educators can now dive beyond lightweight experiments into more hands-on learning. Researchers and business technologists can now start to develop credible proofs-of-concept that demonstrate the potential value of quantum to leaders.

This is the same open plan on the same platform—but now with an added opportunity to help users take the next step on their quantum journeys. IBM remains committed to open science, exploration, and innovation. We're excited to see how this update will enable anyone to explore, experiment, and contribute to scientific progress.

What's new at IBM Quantum?

The IBM Quantum team releases new tools, capabilities, and resources at such a blistering pace that it can be difficult to keep up! Here's a snapshot of the latest and greatest, along with convenient links to get readers exploring them right away.

IBM Quantum Open Plan gets a boost
We're enhancing the IBM Quantum Open Plan with expanded QPU access, new learning resources, and a one-time offer: get 180 free runtime minutes after using 20 minutes in any 12-month window. Learn more on the IBM Quantum blog.

Qiskit SDK v2.3 adds speed and flexibility
Qiskit v2.3 delivers expanded C API capabilities for custom transpiler passes, faster circuit-to-hardware mapping, and early explorations of fault-tolerant architectures. Find more details in the v2.3 release notes.

Introducing Qiskit Fermions
Qiskit Fermions is a new quantum chemistry library that extends Qiskit with tools for fermionic systems. Use built-in fermionic mappers, operator tools, and an extensible circuit-synthesis library—or build your own mappers and circuits with Python or the C API. Explore Qiskit Fermions on GitHub.

A blueprint for quantum-centric supercomputing
IBM has released a new architecture for bringing quantum computing into HPC data centers. See how CPUs, GPUs, and QPUs combine in quantum-centric workflows, and explore our roadmap for scaling hybrid systems. Read more on the IBM Research blog.

New course: Quantum + HPC workflows
Learn how quantum and HPC work together in our new course, "Integrating quantum and high-performance computing." Get practical guidance on compute resources, workflows, and an SQD walkthrough—all available for free on IBM Quantum Learning.

Qiskit Functions Catalog adds real-time logs
New real-time logs for Qiskit Functions deliver valuable details on current execution stage, optimization techniques applied to your workload, and job metadata, as well as information to help you debug and analyze Functions faster. Use job.logs() to try this out with your Function jobs.

New QPUs join the IBM Quantum Fleet
Our first Nighthawk QPU, ibm_miami, is now available as an exploratory device for users on our Premium, Flex, and Pay-As-You-Go plans. We've also deployed our most performant Heron processors to date, with the Heron r3 QPUs ibm_boston in the U.S. and ibm_aachen in the E.U. Explore the new QPUs.

As we move deeper into 2026, we're continuing to expand what's possible with quantum computing. Explore these updates, try out the new tools, and keep an eye on the IBM Quantum blog to see what comes next. There's much more on the way.

Charlie Bennett wins Turing Award ↗

What it is: IBM Fellow and pioneering quantum physicist Charles H. Bennett received the A.M. Turing Award, computing's highest honor. The award, shared with longtime collaborator Gilles Brassard of the Université de Montréal, cited contributions that helped spark a "quantum revolution," establish the field of quantum information science, and reshape how researchers think about computation, communication, and the nature of information itself.

Why it matters: Bennett's five decades at IBM Research helped transform quantum theory into practical advances like quantum cryptography, quantum teleportation, and entanglement-based protocols. He is the seventh IBMer recognized with the award by the Association for Computing Machinery. The recognition joins IBM's long legacy of shaping quantum computing and the enduring impact of researchers who defined the field.

Differential equations for quantum speedup ↗

What it is: IBM researchers have developed a new quantum algorithm that may offer an exponential speed-up over classical methods under certain conditions. The algorithm efficiently solves differential equations, which describe the dynamics of quantities that change over time for turbulent fluid dynamics systems that are both dissipative and noisy. The team also proved that their algorithm was BQP-complete, indicating a mathematical structure that classical methods can't efficiently handle—a key benchmark for quantum advantage.

Why it matters: This new work is a step toward delivering on the potential of quantum algorithms for solving differential equations with an exponential speedup. Classical algorithms struggle with the sheer complexity of the turbulent systems that describe many real-world scenarios, so a verifiable quantum speedup in this area would be impactful. The team is already building on their advances to study commercially-relevant problems, such as the broadly-applicable Navier-Stokes equation in three spatial dimensions. Over the longer-term, improved quantum algorithms for differential equations could have use cases as diverse as financial modeling, vehicle design, and weather prediction.

India's IBM quantum computer ↗

What it is: Construction has begun on Quantum Valley Tech Park in Amaravati, a city in the Indian state of Andhra Pradesh. This site will host an IBM Quantum System Two—powered by our latest quantum processor—the first IBM quantum computer to be deployed in India. The Quantum Valley Tech Park is intended to play a significant role in building India's quantum talent pipeline.

Why it matters: Expanding India's quantum talent pool is becoming a bigger priority for the Indian Government, which wants the country to become a major quantum computing hub. Estimates show that India will need to train 100,000 quantum developers to become a leader in the industry. The installation of an IBM Quantum System Two will support quantum talent development by making it easier for developers to gain hands-on experience with advanced quantum computers and test algorithms in real-world settings.

Closed-loop quantum-centric supercomputing ↗

What it is: A recent IBM blog post explores RIKEN and IBM's recent milestone in quantum-centric supercomputing (QCSC). The supercomputer Fugaku and RIKEN's on-premises IBM Quantum Heron processor ran the largest and most accurate chemistry experiment ever performed with a quantum computer. Together, the supercomputer and quantum computer tackled the workflow using sample-based quantum diagonalization (SQD), part of the new class of algorithms designed for QCSC, to calculate the electronic structure of a pair of iron-sulfur molecules.

Why it matters: This work is the first large-scale demonstration of quantum and high-performance computing working in a closed loop and is a step toward demonstrating quantum advantage. The researchers developed a novel task assignment system for tightly orchestrating quantum and classical resources that could make future QCSC applications easier to implement. The next step is integrating GPU accelerators into the quantum-classical workflows, which the researchers think may even open up a pathway to achieving quantum advantage at RIKEN this year.

Multi-objective optimization ↗

What it is: A collaboration between researchers from Zuse Institute Berlin, Los Alamos National Laboratory, and IBM have developed a new quantum algorithm for tackling multi-objective optimization problems. Named quantum approximate multi-objective optimization (QAMOO), the new algorithm improves on the well-studied quantum approximate optimization algorithm (QAOA) by adapting it for complex problems that require balancing multiple competing objectives.

Why it matters: Multi-objective optimization stands out as a target for quantum researchers as it's directly applicable to common practical problems, is very difficult for classical methods to handle efficiently, and benefits from well-understood quantum computing strengths like sampling. Based on the results they've already achieved, the researchers view QAMOO as a strong candidate for near-term quantum advantage. Eventually, the algorithm could be used for solving a broad set of real-world optimization problems, with far-reaching commercial applications in major industries like finance, healthcare, logistics, and more.

BasQ Time Crystals ↗

What it is: Researchers from IBM, NIST, and Basque Quantum (BasQ) constructed a 144-qubit, two-dimensional time crystal on an IBM Quantum Heron chip. Time crystals are quantum systems with regularly repeating interval states that generate stable patterns in time, much like the distinctive shapes of snowflakes or table salt maintain molecular patterns in space. As qubits are quantum objects, the researchers didn't merely simulate a time crystal, but created one using qubits as the basic unit.

Why it matters: Better understanding time crystals could shed light on a broad range of "Heisenberg-type interactions" in materials science where the spins of particles influence each other. There are implications for studying single-molecule magnets, metallic chains, and quantum dot-based architectures—a class of nanoscale semiconductors with many technological applications. Further, the work incorporated new error mitigation methods that have the potential to run with the help of GPUs.

Half-Möbius Particle ↗

What it is: IBM and partners at Oxford, the University of Manchester, ETH Zurich, École Polytechnique Fédérale de Lausanne, and the University of Regensburg used quantum-centric supercomputing to engineer and simulate properties of a half-Möbius molecule—a previously unimagined form of matter. A Möbius strip is a planar surface with a twist, requiring two full loops if you ride along its top side. The electronic cloud of the half-Möbius topology instead twists by 90 degrees, requiring four loops to return to the original orientation.

Why it matters: Researchers used quantum computers running an algorithm called SqDRIFT to predict the properties of the molecule and why it was able to switch between the trivial phase and the half-Möbius phase. The complexity of this experimentally realized system is beyond the practical scope of exact classical methods. It demonstrates that continued concurrent advances in atomic manipulation techniques and quantum algorithms promise to deliver increasingly sophisticated tools to help simulate and engineer natural systems.

Thermonat ↗

What it is: IBM researchers developed a new machine learning tool to model thermal semiconductor behavior with atomic-level precision. The work was completed as part of DARPA’s Thermonat (Thermal Design of Nanoscale Transistors) initiative. Machine-learning software trained on IBM’s massive stores of semiconductor data achieved prediction accuracy within one degree, tens of thousands of times faster than the next-best simulation tools.

Why it matters: Heating is a major obstacle for the continued development of semiconductors. New thermal issues arise as leaders in transistor scaling work toward smaller nodes for more processing power. This new machine learning tool developed in collaboration with partners at Ansys can help, providing insight for the design of novel processor cooling systems and enabling engineers to create more thermally aware layouts.

Quantum Networking

Accurate Error Mitigation for Scientific Discovery with Qedma's QESEM

QESEM, Qedma's error-mitigation toolkit, is showing value as a tool for scientific exploration with quantum computers. QESEM is a Qiskit Function, enabling researchers to plug advanced error mitigation directly into their workflows without building bespoke pipelines. This is an important part of how we want the ecosystem to scale: specialized providers build high-performance functions while users can run them seamlessly, leveraging IBM Quantum hardware and classical resources to push into regimes that classical tools cannot reach.

QESEM excels in part due to extremely fine-grained error characterization.

"You first need to diagnose the errors with very high precision before you can mitigate them," said Qedma CTO Netanel Lindner.

The function can model the noise present in a quantum computer with enough precision to extract signals that would otherwise be quite faint. This includes accurate mitigation of fractional-angle gates, which are essential for faithfully capturing continuous-time dynamics in many quantum simulations. That pushes the horizon of what's possible with today's quantum computers, enabling them to enter complex, deeply entangled regimes that have never been experimentally accessible before.

A recent collaboration among Qedma, IBM, RIKEN, and BlueQubit focused on generic two-dimensional Ising dynamics, or grids of tiny on-off magnets that interact with their neighbors. Researchers use these grids to test how large, interacting systems behave. These many-body systems pack entanglement quickly, compressing computational hardness into the available circuit volume. This makes them an efficient path toward scientifically interesting problems at quantum-accessible scales where classical tools struggle.

As these systems evolve in time, they grow more entangled. That spreading entanglement rapidly drives up the classical resources needed to simulate them. That hockey-stick spike in complexity

Accurate Error Mitigation for Scientific Discovery with Qedma's QESEM

makes room for quantum experiments to probe behavior that classical computers struggle to model.

The team ran a Trotterized 2D Ising model on an IBM Quantum Heron processor. Trotterization means approximating continuous time evolution with a sequence of short, discrete steps called Trotter steps that compile into a circuit, often involving fractional-angle operations. By 20 Trotter steps, the circuit already contained more than 1,100 entangling $R_{zz}(\theta)$ gates. Classically simulating the same system on RIKEN's Fugaku supercomputer required about 10,120 CPU-hours across 12,288 cores.

At that scale, different classical methods (sparse Pauli path techniques and tensor network algorithms) begin to offer divergent results. The quantum computer, meanwhile, began to return new, physically meaningful information with the help of QESEM: a stable, physically meaningful magnetization signal, where magnetization is the average spin orientation, well past the point where known classical methods returned divergent results.

This is an exciting hint toward what we hope to see from fully realized quantum computers, said Qedma Chief Scientific Officer and Co-founder Dorit Aharonov. "You run a quantum simulation, you discover a physical behavior you didn't predict before, and then you work to understand it,"

Q&A: Kayla Lee

How would you describe your role?

I'm responsible for our commercial ecosystem—how we work with third parties (startups, GSIs, ISVs, and business partners) with the goal of furthering enhancing our products and services—and also how we work with our access plan clients, such as our Premium and Flex Plan clients who are interested in using IBM for hardware access, plus how we support pipeline development with IBM Quantum credits, nurturing inbound leads, and our adoption data.

How did you end up in this role?

I started at IBM as an intern over eight years ago. At the time, I was finishing a PhD in systems biology and I joined to work in what was then the healthcare and life sciences group. As my internship came to a close, I realized I was interested in the intersection of business, science, and technology. Back in 2018, we were just starting to think about quantum computing as a business. The IBM Quantum Network had already been launched and we were starting to form a consulting arm. I joined as a consultant on our Industry and Technical Services team. From there, I spent time on the community team, where I focused on partnerships and built out the client delivery experience and helped define what access plans might look like as they grew into programs.

Why is ecosystem becoming such a huge topic of discussion nowadays?

Well first, we really can't do any of this by ourselves. If we want to see a robust and thriving quantum industry, we need parties from different, yet interconnected sectors that are providing services, building support technology, experimenting with hardware—and then we have to bring these parties together in the communal pursuit of a destination, like quantum advantage. In the case of IBM, ecosystem is the key for us being intentional about partnerships so we can do the things we can't do by ourselves—or do more of them, faster.

What do you see as being the greatest strengths of our ecosystem?

We're robust across the stack. No other company has the coverage and depth that we have. From a hardware perspective, from software tools and services—we lead across those dimensions. And then in terms of the number of clients we've been able to reach, the various geographies we've been able to establish footprints in—no one else has been able to do that in this way, and it's been really important for our own development.

What is your favorite way of engaging with our ecosystem?

I'd say events in general. Especially having been here pre- and post-COVID, it's nice to see events come back and really be a key fixture of the IBM Quantum experience. My personal favorite is Partner Forum, an annual event that brings together the Network. It's the only event that exclusively features the Network, and it has great energy and engagement.

What do you do outside of work?

Lots of house things. We bought a house recently, so we have been doing a lot of DIY projects—painting and that sort of thing. My big summer project is to plant a garden in the backyard. So I'd say plants, house projects, and a little bit of CrossFit.

Phase Kickback

A decade on the cloud
May 4, 2026 marks the 10th anniversary of IBM putting the first quantum computer on the cloud, a decision that fundamentally changed the course of quantum computing research and kick-started a new global quantum computing industry. Now, as we stand on the precipice of realizing the first demonstrations of verified quantum advantage, it's the perfect time to look back on the many scientific breakthroughs, community efforts, and industry partnerships that have brought us to where we are today.

2016

IBM launches the **IBM Quantum Experience** with a five-qubit device, allowing users to build and run circuits using a graphical composer interface. This initiative brings real quantum hardware out of the research lab and makes it freely available to the public via the cloud for the first time in history, establishing a model for cloud-based quantum computer access that much of the industry still follows today.

2017

IBM publishes the first release of QISkit, an open-source Quantum Information Science software development kit. With Qiskit, users are able to transition from the basic educational demos enabled by a graphical interface to much more complex, scalable quantum programming and execution. As part of the Qiskit rollout, IBM introduces OpenQASM (Open Quantum Assembly Language), a machine-independent programming interface and imperative programming language for describing quantum circuits.

On the hardware side, IBM pushes the qubit counts of its quantum processors into the double digits, making a 20-qubit system available as a cloud service and demonstrating a 50-qubit prototype—a rapid scale-up in system size.

2018

The **IBM Quantum Network (then "IBM Q Network") and an early iteration of the IBM Quantum Premium Plan begin to take shape**, with Fortune 500 companies, national labs, and universities coming together to explore practical applications with early-access systems. This momentum extends globally when Keio University launches **the first IBM Quantum Innovation Center in Asia** (formerly "IBM Q Hub"), expanding the ecosystem and providing access to IBM's premium systems for industry and academia in Japan.

In 2018, **IBM also introduces the first iteration of the Qiskit Transpiler**, a tool that greatly simplifies the process of mapping circuits to specific backends. Before this, transpilation for IBM Quantum hardware relied largely on manual or ad hoc methods that required deep hardware expertise. The transpiler played an important role in lowering the barrier to entry for general users.

Phase Kickback

2019

Qiskit gains **the ability to target multiple architectures and integrate third-party hardware** such as the trapped-ion devices provided by Alpine Quantum Technologies based in Innsbruck, Austria. This effort serves to validate our emerging “write-once, run-anywhere” approach to cloud-based quantum computing.

IBM also unveils IBM Quantum System One, the first integrated quantum computing system built for commercial use, and announces plans for the Quantum Computation Center in Poughkeepsie, New York. Today, that facility is one of two IBM Quantum Data Centers, and it will soon be home to the world’s first large-scale, fault-tolerant quantum computer.

2020

IBM introduces its vision for OpenQASM 3 alongside a re-architected execution model that distinguishes real-time and near-time quantum-classical workflows—**paving the way for dynamic circuits**. Later that year, IBM publishes its first **quantum hardware roadmap** to 1,121 qubits and beyond, setting a new standard for transparent, milestone-driven progress in quantum computing and the technology industry more broadly.

2021

IBM launches Qiskit Runtime, co-locating classical compute with quantum systems to slash latency and demonstrate up to 120× speedups for iterative workloads. Around the same time, IBM delivers its **first on-prem quantum system and first quantum system located outside of the U.S.**, installing an IBM Quantum System One with a 27-qubit IBM Quantum Falcon chip on-site at the headquarters of German research organization Fraunhofer-Gesellschaft. Additionally, 2021 brings **the first experimental OpenQASM 3 specification**, laying the groundwork for the community-governed OpenQASM 3 releases that follow.

At IBM Quantum Summit 2021, IBM delivers a pivotal milestone in quantum computing history with the announcement of the 127-qubit **IBM Quantum Eagle**, **the first quantum chip to break the 100-qubit barrier**. This achievement ushers in a new era of what we now call utility-scale processors, fundamentally expanding the size and complexity of quantum circuits that we’re able to explore on real hardware.

2022

IBM introduces **Qiskit Runtime primitives (Sampler and Estimator)** to simplify the process of running jobs on and getting useful results from quantum computers. As part of that announcement, **IBM rolls out the beta version of the Pay-As-You-Go Plan on IBM Cloud**, allowing users to access premium quantum systems and pay only for resources used—no need to commit to the IBM Quantum Premium Plan. That same year brings the **launch of Qiskit Runtime sessions, an early version of what we now call execution modes.**

Phase Kickback

2023

IBM and UC Berkeley demonstrate the landmark quantum utility experiment, delivering some of the first concrete evidence showing that error-mitigated quantum circuits at the scale of 100+ qubits can return accurate, useful results beyond brute-force classical simulation. IBM Quantum Summit 2023 sees **the debut of both the IBM Quantum Heron processor family and IBM Quantum System Two** — previewing our vision of high-performance quantum chips deployed in a modular architecture as the path to long-term system scaling.

2024

Qiskit's first major version release—**Qiskit SDK v1.0**—arrives, inaugurating a new era of performance and API stability to support circuit development at the scale of 100+ qubits and beyond. That fall, **IBM launches the Qiskit Functions Catalog**, a higher-level programming model that abstracts away many of the complexities of quantum software development to accelerate application prototyping and lower the barrier to entry for application researchers. The same period marks the opening of **the first IBM Quantum Data Center in Europe**, expanding the region's access to utility-scale quantum computers.

2025

IBM kicks off the year with an ambitious project, **migrating the entire IBM Quantum Platform to IBM Cloud** to enable new features and greater security for users. Soon after, **IBM lays out a clear path to delivering large-scale, fault-tolerant quantum computing by 2029**, adding new proof-of-concept processors like the IBM Quantum Loon to an updated IBM Quantum Roadmap.

On the software front, **Qiskit's new C API opens the door to end-to-end, compiled quantum + HPC workflows** in popular HPC programming languages like C, C++, and even Fortran—a key step on the road to an emerging computational paradigm we call quantum-centric supercomputing.

2026

Ten years after putting the first quantum computer on the cloud, **IBM debuts a reference architecture for integrating quantum compute into CPU/GPU clusters in HPC data centers**—a blueprint to operationalizing hybrid quantum-centric supercomputing architectures at scale. As the year progresses, we also begin to see a genuine race taking place between quantum and classical methods through open-source community efforts like the **Quantum Advantage Tracker, an initiative that we believe will see the first demonstrations of verifiable quantum advantage by the end of the year**.

Phase Kickback

References

2016	IBM Makes Quantum Computing Available on IBM Cloud to Accelerate Innovation, IBM Newsroom.
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2017	IBM Announces Collaboration with Leading Fortune 500 Companies... to Accelerate Quantum Computing, IBM Press Release.
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2019	Qiskit: write once, target multiple architectures, Javadi-Abhari, A.
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Phase Kickback

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2022 Pay as You go Quantum. Strangeworks and IBM introduce ‘Pay-As-You-Go-Plan’ for Qiskit Runtime on IBM Cloud, Kyrlynn D.

Phase Kickback

References continued

2023	A new paper from IBM and UC Berkeley shows a path toward useful quantum computing, Mandelbaum, R.
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2024	How execution modes enable efficient, utility-scale workloads, Constantinescu, A. et al.
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2024	Announcing the Qiskit Functions Catalog, Nur, S. et al.
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2025	How IBM will build the world's first large-scale, fault-tolerant quantum computer, Mandelbaum, R.
2025	Qiskit C API enables new end-to-end quantum + HPC workflows, Garrison, J. et al.

Phase Kickback

References continued

2026

How IBM is helping the world realize Richard Feynman's vision for the future of simulation, Chow, J. & Mandelbaum, R.

2026

Quantum Advantage Tracker: the race to advantage, Gambetta, J. M. & Davis, R. M.

Error Mitigation

Know your loons!

Each year, our innovation roadmap introduces a new chip showcasing the critical science advances required to realize fault-tolerant quantum computing. It also introduces the quantum community to a new bird. This year we announced Loon—a chip that debuts the components required to build our scalable fault-tolerant quantum computing architecture.

So, what is a loon? Loons are long-billed water birds that breed in northern lakes and ponds. Their feet are positioned far back on their bodies, making them clumsy on land—but they're adept swimmers capable of diving several hundred feet deep in pursuit of fish. Most loons molt into less dramatic plumage each winter before migrating to ocean coasts.

Common Loon

Common Loons breed in North America's pristine northern conifer forests, where their haunting wails are a distinctive summer sound. Breeding pairs are famously territorial and will chase intruding loons off their lake—and in one shocking case, a Common Loon killed a Bald Eagle that went after its chicks. (Image credit: Ryan Mandelbaum)

Yellow-billed Loon

Yellow-billed Loons are much rarer than their common cousins with larger, banana-yellow beaks. These birds only breed on tundra ponds north of the tree line in Siberia, Canada, and Alaska. They migrate to the nearest unfrozen sea coast in winter, but sometimes get lost—like one who ended up in the fountain of Las Vegas' Bellagio Hotel. (Image credit: Bob Wick, BLM)

Pacific Loon

The Pacific Loon lives mainly in North America, where it's the most abundant loon. They summer in larger, deeper ponds than other loons, and then migrate in massive flocks, with bird migration counters sometimes tallying tens of thousands of birds in a day. (Image credit: Lisa Hupp/USFWS)

Arctic Loon

Considered the Eurasian counterpart of the similar-looking Pacific Loon, ornithologists only deemed this a unique species in 1985. This species breeds from Scandinavia eastward to Alaska favoring large lakes, moving to northern European and eastern Asian coasts each winter. (Image credit: Robert Bergman, USFWS)

Red-throated Loon

This smallest loon inhabits tundras across the northern hemisphere, but differs greatly from its cousins in appearance and behaviors. It favors smaller ponds, and rather than spending all of its time on its home lake, it travels daily between its nest and larger water bodies for feeding. (Image credit: Jason Crotty)

Upcoming Events

15–16 April
Defining the Future
San Bernardino, CA, US

16 April
IBM Quantum Connect: Mexico City
Mexico City, MX

21–24 April
Working Group: Sustainability
Heidelberg, Germany

28–30 April
Quantum Australia
Adelaide, Australia

3–6 May
GEOINT 2026
Aurora, Colorado, US

4–7 May
IBM Think 2026
Boston, MA, US

8 May
IBM Quantum–Advancing Quantum Algorithms and Applications
London, UK

12 May
IBM Quantum Connect: Edinburgh
Edinburgh, Scotland, UK

14–15 May
Society of Petroleum Engineers Workshop
Houston, TX, US

19 May
IBM Quantum Connect: APAC
Seoul, South Korea

28–29 May
Working Group: Materials Science
San Sebastian, Spain

2–4 June
IBM Quantum Partner Forum
Madrid, Spain

4–5 June
Q2B Tokyo
Tokyo, Japan

9 June
IBM Think Gov
Washington, DC, US