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CURRENTSOTA

Physical qubits	1,180
2Q fidelity	99.99%
Logical qubits	96 LQ

Quantum hardware SOTA table →

Aug 1, 2026 – Aug 2 · Daily Brief

IBM量子计算机首次以逻辑比特破解超算难题

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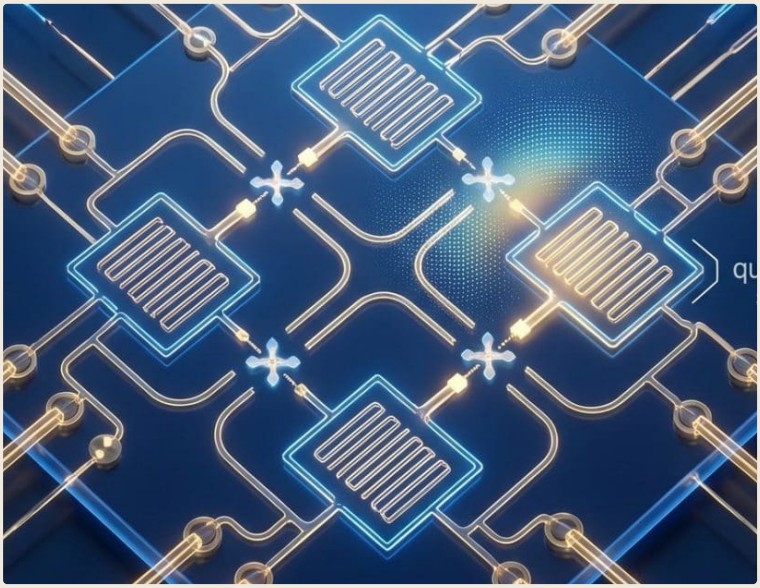
01 Highlights

Highlights

IBM and the University of Chicago jointly demonstrated 70 logical qubits, solving a problem intractable for classical supercomputers in approximately 15 minutes, marking the first verification of quantum advantage under a trusted quantum computing framework [17]. This work employs a novel error correction method, pushing the logical qubit count further toward practicality from QuEra's record of 96, but encoding efficiency and cycle repetition rate still require improvement [17].

02 Hardware

Hardware Frontier



Superconducting Qubits

— IBM and the University of Chicago used a novel error correction method to encode 70 logical qubits, cracking a classically hard problem in about 15 minutes, verifying quantum advantage for the first time under a trusted quantum computing framework [17]. **Why it matters**: The logical qubit count surpasses QuEra's record of 96 (the latter being a neutral atom platform), and it achieves the first trusted quantum computing demonstration, marking a major breakthrough in error correction capability for the superconducting route; however, the evidence level for this result is currently E3 (preprint), requiring independent replication for confirmation, and logical qubit fidelity and the surface code Λ value have not been disclosed, still lacking real-time error

correction and low error rate demonstrations for practical use.

- A novel hybrid superconducting qubit suppressed odd-order harmonics by two orders of magnitude by controlling Cooper pair tunneling [15]. **Why it matters**: Odd-order harmonics are key factors causing decoherence and crosstalk in superconducting qubits; suppressing them by two orders of magnitude is expected to significantly improve qubit coherence and gate fidelity, potentially bringing the T1/T2 of superconducting qubits close to current SOTA levels (e.g., Google Willow's ~100 μs), but this result is only a device-level demonstration and has not yet been integrated into multi-qubit systems.
- Time-crystalline order was observed in superconducting qubits and maintained for 120 cycles [16]. **Why it matters**: Time crystals are novel non-equilibrium phases of quantum many-body systems. Achieving stable oscillations for 120 cycles on a superconducting platform sets a new record for cycle number compared to previous similar experiments (typically only tens of cycles), providing a new platform for exploring dynamical phase transitions in quantum systems, but the direct relevance of this phenomenon to practical quantum computing remains unclear.

Neutral Atom Qubits

— Researchers extended the lifetime of Rydberg collective excitations by nearly a factor of 9 through a new addressing scheme [9]. **Why it matters**: Rydberg excitation lifetime is a key limiting factor for neutral atom quantum gate operations. A 9-fold extension implies that gate error rates could be significantly reduced, potentially pushing two-qubit gate fidelity beyond the current SOTA of 99.5%–99.6%, but this technique has not yet been validated in parallel gate operations, and the neutral atom route still faces the bottleneck of low cycle repetition rates (typically 1–10 Hz).

Qubit Technology

— A new qubit suppresses odd-order harmonics by two orders of magnitude by controlling Cooper pair tunneling [15] (see Superconducting section for details).

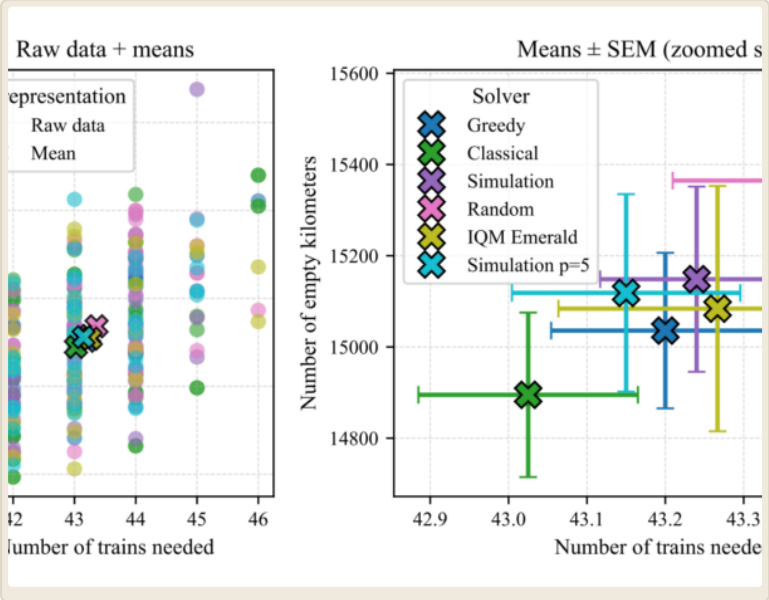
Quantum Simulation

— Two Hands Corporation's EntangleX quantum circuit simulation software begins external Beta testing [1]. **Why it matters**: As a quantum circuit simulator, its performance compared to existing tools (like Qiskit, Cirq) is unclear, but if it can offer differentiated advantages in specific scenarios, it may provide a new option for quantum algorithm development; currently in

early stages, its impact on the industry landscape is limited.

03 Algorithms

Algorithms & Software



Quantum Error Correction

— IBM and the University of Chicago encoded 70 logical qubits using a novel error correction method, solving a classically hard problem in about 15 minutes [17] (see Hardware Frontier for details).

— A general cumulant expansion framework was used to analyze correlated coherent errors in stabilizer codes, yielding a tractable expression for logical infidelity [12]. **Why it matters**: This framework goes beyond standard noise models, enabling more accurate prediction of

logical error rates, providing a key theoretical tool for designing fault-tolerant quantum computers, and potentially accelerating the optimization of error-correcting codes, but its practical effectiveness needs validation on experimental platforms.

Quantum Optimization

- IQM partnered with Deutsche Bahn to execute a hybrid quantum-classical optimization algorithm on the 54-qubit IQM Emerald processor, addressing a rail vehicle scheduling problem [2]. **Why it matters**: This is an end-to-end demonstration of quantum computing on real industrial data, showcasing the potential of quantum optimization in logistics; although the 54-qubit scale lags behind superconducting SOTA (e.g., IBM's 120 qubits), its performance on specific optimization problems might be comparable to classical heuristics, but larger scale and higher fidelity are still needed for practical use.

- The Quantum Information Subsampling (QISS) framework was validated on the 54-qubit IQM Emerald device, achieving competitive optimization results, even surpassing QAOA [8]. **Why it matters**: QISS is a noise-resilient optimization framework that outperforms QAOA on existing quantum hardware, implying it could become a new benchmark for near-term quantum optimization algorithms, but it still

cannot solve real-world large-scale problems at the 54-qubit scale and requires validation on larger systems.

Quantum Machine Learning

— Cleveland Clinic and IBM developed the Q-CHIPP quantum machine learning framework for predicting immunogenic neoantigens arising from tumor gene mutations [7]. **Why it matters**: This work, published in *Science Advances*, applies a quantum convolutional neural network to cancer neoantigen prediction for the first time, potentially offering greater efficiency than classical methods on specific datasets, but quantum advantage has not been rigorously proven, and it relies on near-term quantum hardware, remaining some distance from clinical utility.

Industry & Ecosystem

Enterprise Deployment & Partnerships

- EY deployed an on-premises quantum computer in Canada as part of its global enterprise technology strategy [3]. **Why it matters**: A Big Four accounting firm directly procuring quantum hardware signifies quantum computing's move from the lab to enterprise-level applications, potentially accelerating the implementation of quantum algorithms in sectors like financial services, but the specific hardware model and performance were not disclosed, and actual utility remains to be seen.
- IQM partnered with Deutsche Bahn to execute a hybrid quantum algorithm for solving a railway scheduling problem [2] (see Algorithms section for details).

Policy & Funding

— NSF awarded $18 million to UC San Diego to establish an MRSEC focused on quantum materials development, as part of a $108 million national materials initiative [5]. **Why it matters**: This investment will advance the R&D of novel quantum materials, potentially providing better materials for superconducting, topological, and other qubit platforms, with a long-term impact on quantum computing hardware performance, but it is unlikely to break through existing bottlenecks in the short term.

Market & Ecosystem

— Two Hands Corporation's EntangleX quantum simulator begins external Beta testing [1] (see Hardware Frontier for details).

— Vexlum established an R&D lab in the UK and appointed Dr. Stefan Truppe as General Manager, focusing on VECSEL laser technology [4]. **Why it matters**: VECSEL lasers are key components for ion trap and neutral atom quantum computers; Vexlum's expansion may accelerate the commercialization of high-performance lasers and reduce quantum hardware costs, but attention must be paid to whether its technical specifications meet quantum computing demands.

— The Quantum Science Institute at the U.S. Naval Research Laboratory coordinates naval quantum information science efforts, developing technologies for navigation, sensing, and secure communication [14]. **Why it matters**: Continued military investment in quantum technology indicates its strategic value in defense, potentially driving the practical application of quantum sensing and communication, but its direct impact on the quantum computing industry landscape is limited.

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05 Other

Academic Frontier

Quantum Error Correction & Noise

— Cumulant framework analyzes correlated coherent errors in stabilizer codes [12] (see Algorithms section for details).

Quantum Control & Measurement

— Kalman filter used for magnetic field stabilization in ultracold atom experiments, eliminating drifts up to 70 nT/hour [13]. **Why it matters**: Magnetic field drift is a major source of decoherence in ultracold atom experiments; this technique elevates magnetic field stability to a new level, potentially directly improving the coherence time of neutral atom and ion trap qubits, but it has not yet been integrated and validated with quantum gate operations.

Time Crystals & Dynamics

— Time-crystalline order observed in superconducting qubits and maintained for 120 cycles [16] (see Hardware Frontier for details).

Quantum Algorithms & Applications

— Cleveland Clinic and IBM's Q-CHIPP framework for cancer neoantigen prediction [7] (see Algorithms section for details).

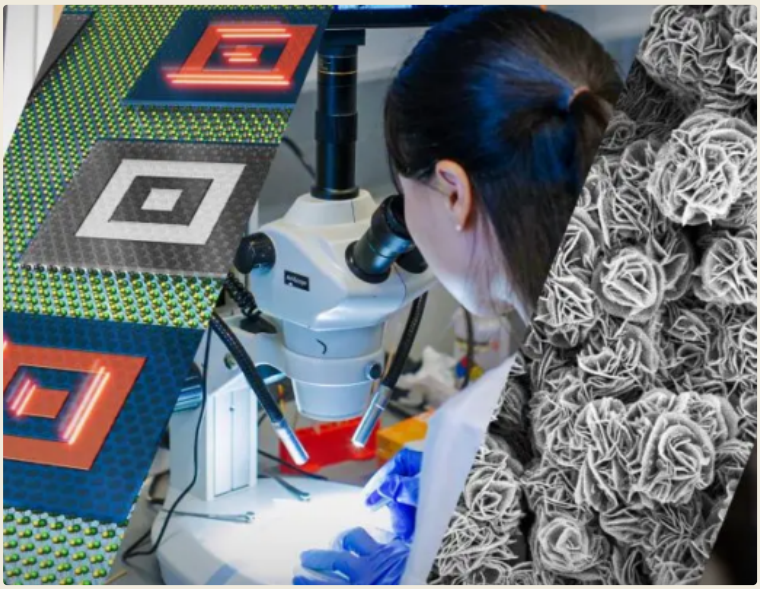
— QISS optimization framework validated on a 54-qubit device [8] (see Algorithms section for details).

Other

- Gil Kalai published an opinion piece arguing that noise may ultimately prevent the realization of quantum computers [18]. **Why it matters**: As a prominent quantum computing skeptic, Kalai's views continue to spark academic discussion, but current experimental progress (such as logical qubit demonstrations) has partially refuted his earlier claims; this article may influence public and investor confidence, requiring attention to whether his specific arguments address the latest advances.
- A retrospective on Lov Grover's contributions [11]: Grover's search algorithm is one of the foundational algorithms of quantum computing; its historical review helps understand the origins of quantum advantage but has no direct impact on current technological development.

06 Impact

This Week's Impact



— **Boost for the superconducting quantum computing route**: The 70-logical-qubit demonstration by IBM and the University of Chicago [17] indicates that the superconducting route can compete with neutral atoms in error correction capability, potentially influencing investor and government confidence in the superconducting route; subsequent independent replication of this result and logical error rate data need attention.

— **Acceleration of enterprise quantum computing applications**: EY's on-premises quantum computer deployment [3] and IQM's partnership with Deutsche Bahn [2] show quantum computing moving from research to industry pilots; enterprises in financial services and logistics may accelerate quantum technology exploration, but caution against hype is warranted.

— **Major funding for quantum materials research**: NSF's $108 million materials initiative [5] will support quantum materials development long-term, potentially providing a foundation for hardware performance improvements, but it is unlikely to change the hardware competitive landscape in the short term.

— **Enhanced theoretical tools for noise analysis**: The cumulant framework [12] provides a new tool for error-correcting code design, potentially helping researchers more accurately assess the fault tolerance of near-term quantum hardware and influencing the design of error correction experiments.

— **New challenges for the neutral atom route**: While the extended Rydberg excitation lifetime [9] improves neutral atom performance, IBM's logical qubit demonstration [17] shows the superconducting route rapidly catching up in logical qubit count; neutral atoms need continued breakthroughs in cycle repetition rate and logical gate fidelity to maintain their lead.

07 Other

Editor's Note

The most striking advance this week is the trusted quantum computing demonstration of 70 logical qubits presented by IBM and the University of Chicago. If independently replicated, this result will mark a new phase for quantum error correction: the logical qubit count approaches the hundred level for the first time, with a preliminary verification of quantum advantage. However, the encoding efficiency and error rate of this demonstration have not been disclosed; its actual fault-tolerant capability remains to be assessed compared to Quantinuum's 2:1 encoding ratio or QuEra's 96 logical qubits. The breakthrough in logical qubits on the superconducting platform could reshape the technological competition landscape; previously, neutral atoms led in logical qubit count, but the superconducting route has traditional advantages in gate speed and integration. On the industry side, enterprises like

EY are beginning to deploy quantum hardware directly, indicating that quantum computing is moving from the lab to real-world application scenarios, but early deployments are more about strategic positioning, and true commercial value still requires years of validation. Academically, foundational research such as noise analysis frameworks and time crystals continues to deepen, providing theoretical support for long-term development, but the core challenge for near-term quantum computing remains improving the quality and quantity of logical qubits.

References

[1] Two Hands Corporation Begins External Beta Testing for EntangleX Quantum Simulator

[2] IQM and Deutsche Bahn Execute Hybrid Quantum Algorithm for Railway Scheduling

[3] EY Expands In-House Capabilities with On-Site Quantum Computer Hub in Canada

[4] Vexlum Establishes UK Operations and Appoints Dr. Stefan Truppe as Managing Director

[5] NSF Awards UC San Diego $18 Million MRSEC Grant for Quantum Materials Development in $108 Million National Materials Initiative

[6] Podcast with Cierra Lunde and Mike Kilroy from HKA Marketing Communications

[7] Cleveland Clinic and IBM Develop Quantum Machine Learning Model for Cancer Neoantigen Prediction

[8] 54-Qubit Device Validates Noise-Resilient Optimization Framework

[9] Rydberg Quantum Spinwaves Last 9× Longer With New Addressing Scheme

[10] EY Deploys On-Site Quantum Computing for Enterprise Transformation

[11] Lov Grover, The Engineer Who Taught Quantum Computers To Search

[12] Cumulant Framework Analyzes Quantum Noise Beyond Standard Models

[13] Kalman Filter Reduces Magnetic Field Drift in Quantum Gas Experiments

[14] NRL's Quantum Science Institute Coordinates Navy's QIST Research

[15] New Qubit Suppresses Odd Harmonics by Two Orders of Magnitude

[16] Superconducting Qubits Show Time-Crystalline Order for 120 Cycles

[17] IBM & Chicago Verify Quantum Advantage With New Error Correction

[18] Gil Kalai (Hebrew University / Reichman University): Why noise may doom quantum computers

[19] The case for AI people really trust