Quantum Computing at Fujitsu

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Fujitsu Research, Fujitsu Limited

Shintaro Sato

March 28, 2025

Fujitsu's Strategy for Quantum Computing

FUJITSU

- Cover all the technology layers with the world's leading research institutions
- Put emphasis on software technologies, while working on several types of hardware
- Develop applications with end users by using Hybrid Quantum Computing Platform

Quantum Application	Research with end-user input: **Materials** | **Drug discovery** | **Finance**	**FUJIFILM, Tokyo Electron, etc.**	**TU Delft**
Quantum Software	**QunaSys** Algorithm **Keysight Technologies** Error Suppression	**Osaka Univ.** Error Correction	
Quantum Platform	Middleware Complier	Cloud Technology	
Quantum State Control Quantum Device & Integration	**RIKEN** Superconducting Qubit **TU Delft** Diamond Spin Qubit	Exploring other possibilities, Neutral Atom etc.	

Computing as a Service Vision

FUJITSU

Provide the top-class Computing Technologies “as a Service”

Application

Finance | Material | Energy | Medicine | Meteorology | Disaster Prevention

Platform

AI | Simulation | Data Analytics

Computing as a Service

Low power consumption | Great computing power | Trust platform

Available on Public Cloud

Middleware
OS
Hardware

High Performance Computing (HPC)
A64FX Technology

Quantum-Inspired Technology
Digital Annealer
Quantum Simulator

Quantum Technology
Superconducting Qubit
Diamond Spin Qubit

Photo: By courtesy of RIKEN

Oct. 5, 2023

Release of a 64-qubit Quantum Computer

- Collaboration with Prof. Nakamura

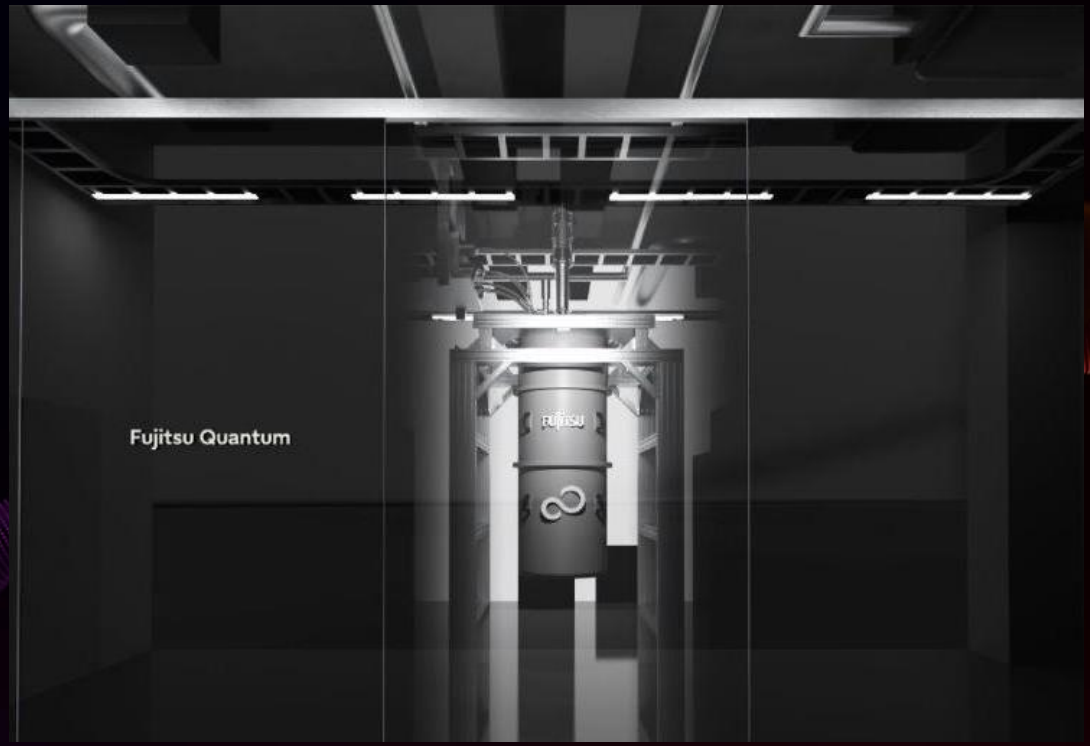
- Developed Japan's second domestic quantum computer at RIKEN RQC-Fujitsu Collaboration Center

A 256-qubit system will be available soon.

Our First Commercial Quantum Computer

FUJITSU

- Delivered to AIST
- We also plan to sell prototype systems overseas.



1000-Qubit System: Under Development

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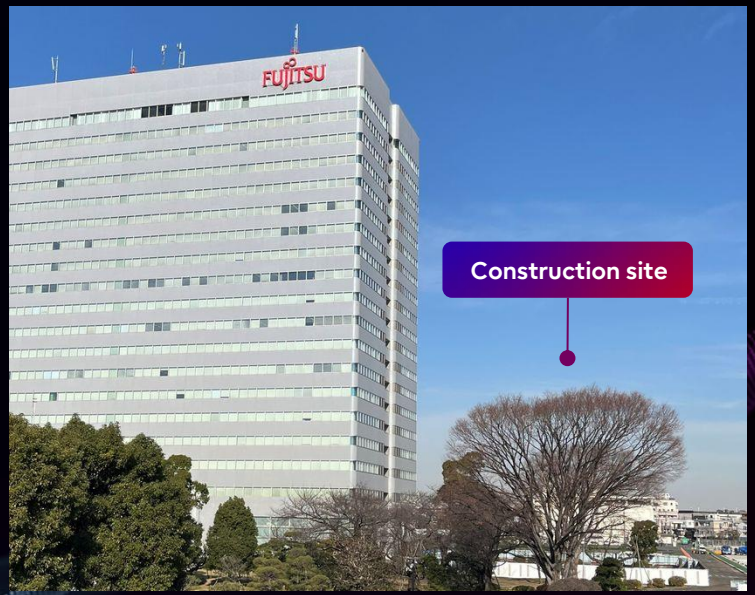
- The construction of facility to house a 1000-qubit quantum computer is underway.
- We are planning to launch the 1000-qubit system in FY2026.



Quantum Computer Simulator

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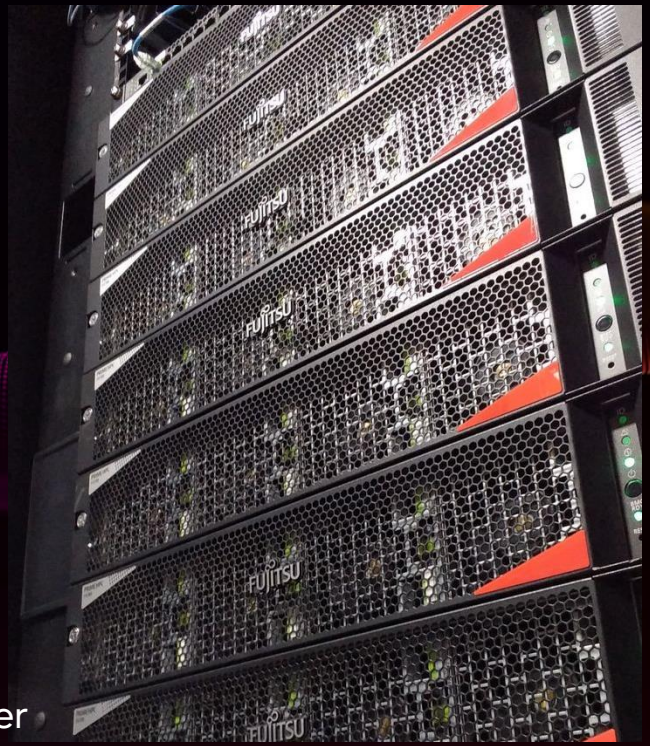
The world largest-class quantum computer simulator as a permanent dedicated system

- Qulacs (state vector simulator) on FX700 cluster
- Continuous enhancement
  36qubits (64 nodes: FY21) → 40qubits (1024 nodes: FY23)



Collaboration with customers

- Material (Fujifilm), Finance (Mizuho-DL Financial Technology)
- Quantum challenge: Application discovery with universities and companies around the world (US, Europe, Asia and Oceania)

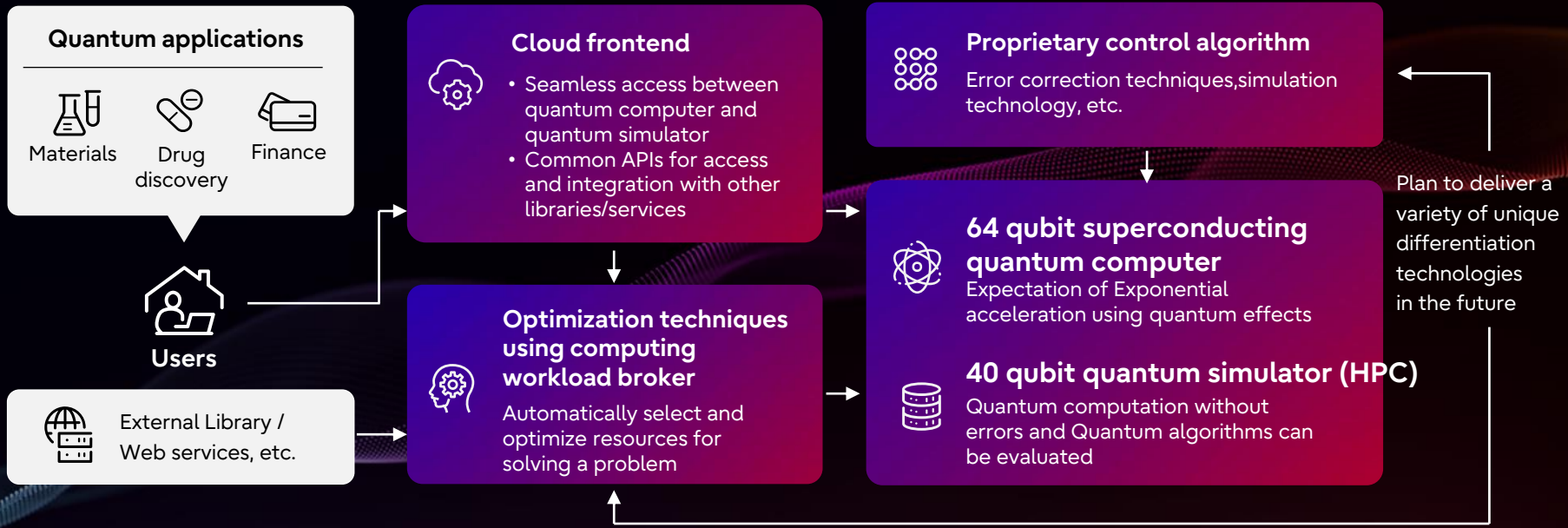
Research on new-type simulators for larger scale

- Tensor Network simulator with Barcelona Supercomputing Center
- Decision Diagram simulator with the University of Tokyo

Platform for Hybrid Quantum Computing

RIKEN QUANTUM COMPUTING | FUJITSU

- Seamless operation between quantum computer and quantum simulator
- Development of computational methods that take advantage of both quantum computers and quantum simulators

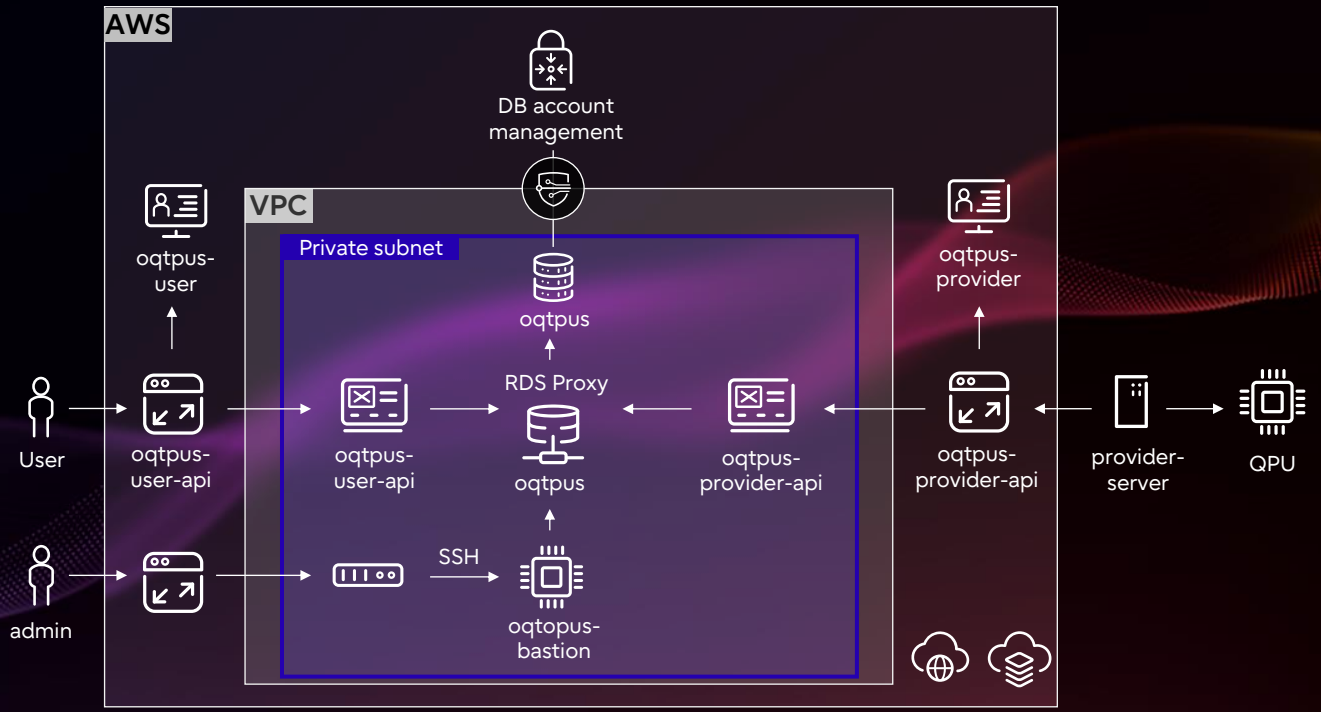


Release of platform software as OSS

大阪大学 OSAKA UNIVERSITY | FUJITSU

Open Quantum Toolchain for Operators and Users

- Developed with Osaka Univ. https://github.com/oqtopus-team
- Released V1.0 in Mar. 2025 after beta release in Sep. 2024
- Implemented on the production system at Osaka Univ.
- User/job/device management function on cloud
- Pre-/post-processing functions on the edge side



Diamond-Spin Modular Technologies for Scalable Quantum Computer

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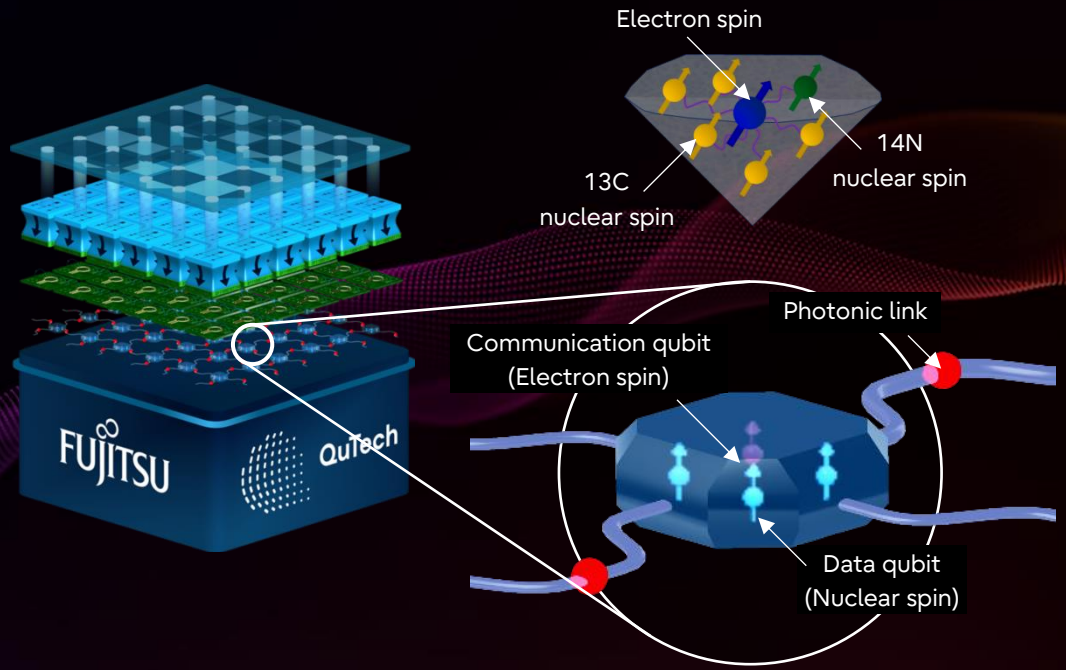
- Each quantum module consists of an electron spin and nuclear spins in a diamond.
- Quantum modules are connected by photonic links, which can be used as one quantum computing system.
- This approach can allow for high-temperature operation (> 1 K) and good scalability.

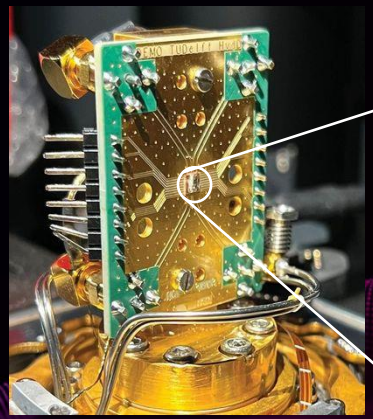


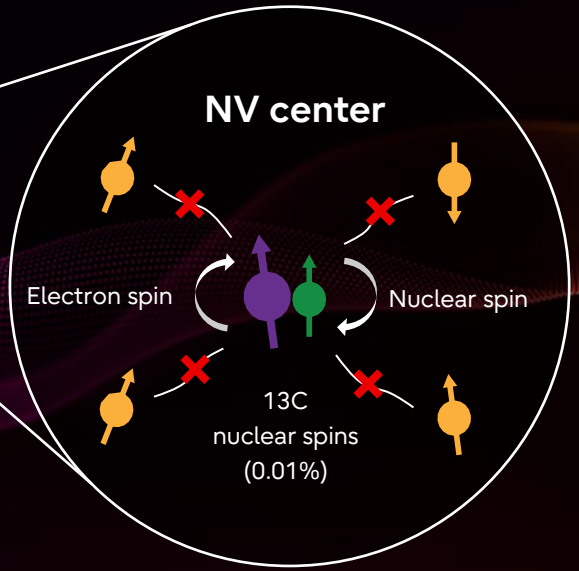
FUJITSU TU Delft QuTech

High-Fidelity Quantum Gates in Diamond Spin Qubits

FUJITSU

- World's first demonstration of quantum gate operations for diamond spin qubits with an error probability below 0.1%.
- Achieved gate fidelity: > 99.9% for 2 qubits, > 99.99% for electron spin, > 99.999% for nuclear spin.





H.P. Bartling et al.,
Phys. Rev. Applied 23, 034052 (2025).

FUJITSU TU Delft QuTech

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FUJITSU TU Delft Delft University of Technology QuTech

March 24th, 2025

Fujitsu and QuTech realize high-precision quantum gates

World-first sub-0.1% error probability in diamond spin quantum gates marks important step toward practical quantum computing

Fujitsu Limited

News Facts:

- Fujitsu and QuTech achieve a world-first sub-0.1% error probability in a complete universal quantum gate set [1] for diamond spin qubits, exceeding the threshold for quantum error correction, an important step towards fault tolerant quantum computing (FTQC) and the practical application of quantum computers
- High-purity diamonds with reduced carbon-13 isotope concentration and advanced performance

https://www.fujitsu.com/global/about/resources/news/press-releases/2025/0324-02.html

Improvement of STAR Architecture

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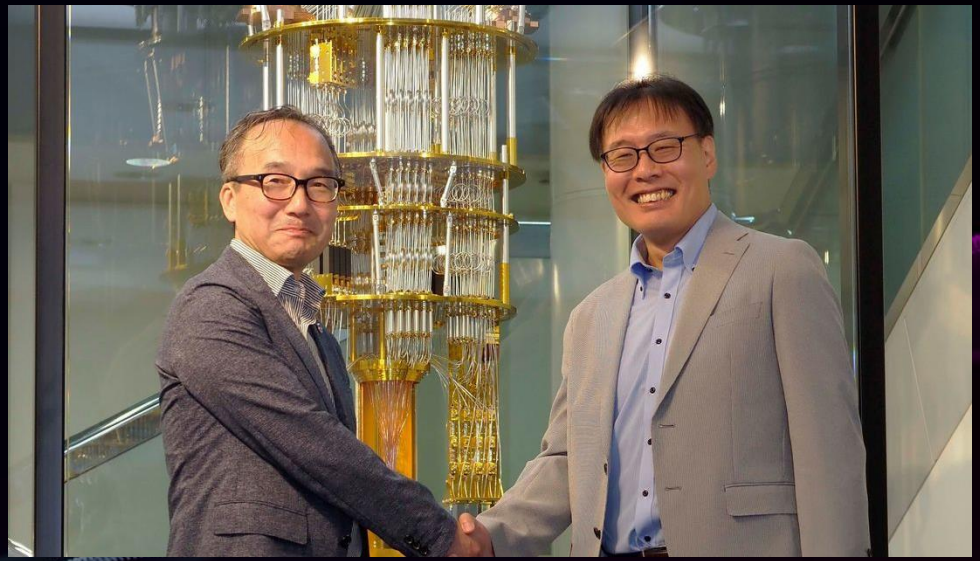
We have improved the architecture so that we can achieve “quantum advantage” for practical applications by just using 60,000 qubits.



Right: Prof. Fujii at Osaka Univ.

Fujitsu and Osaka University accelerate progress toward practical quantum computing by significantly increasing computing scale through error impact reduction in quantum computing architecture

New technologies establish method to run practical quantum algorithms faster than current classical computers with fewer qubits

Fujitsu Limited, Osaka University

Kawasaki and Osaka, August 28, 2024

Y. Akashoshi, et al., *PRX Qunatum* **5**, 010337 (2024)
R. Toshio, et al., arXiv: 2408.14848
Y. Akahoshi, et al., arXiv: 2408.14929
https://pr.fujitsu.com/jp/news/2024/08/28.html

Quantum Error Suppression (QES) with KEYSIGHT

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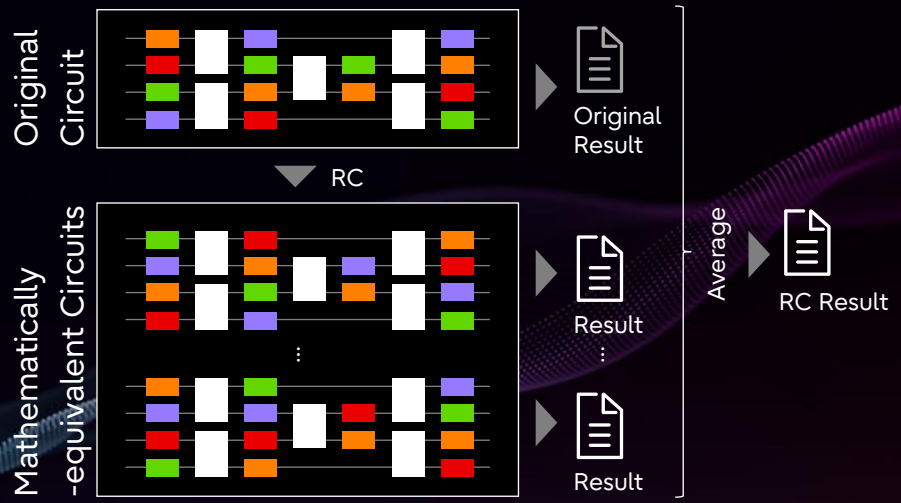
Demonstration of QES effects in Grover's quantum search algorithm with simulations and experiments on a trapped-ion quantum device.

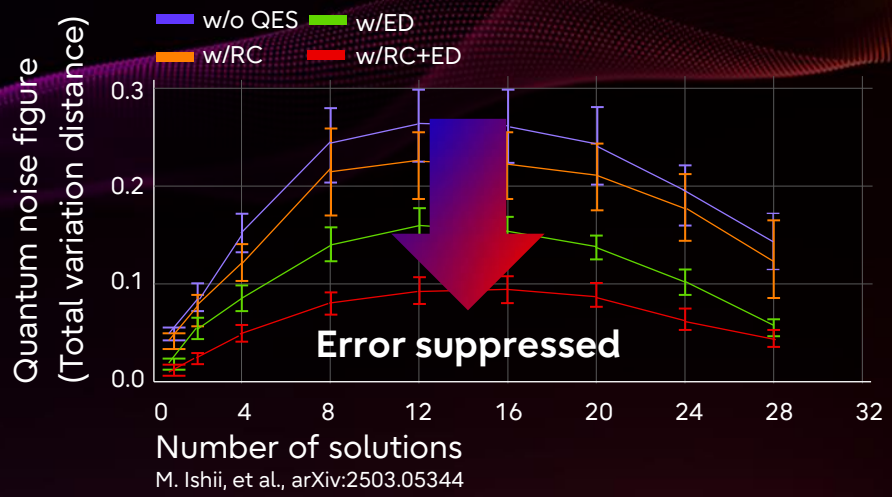
RC achieved suppression of error and its variation. This is expected to be effective even when using more qubits.

＊QEC technology: Randomized Compiling (RC) and Error Detection (ED)

Overview of RC



Sim. Results of six-qubit Grover



M. Ishii, et al., arXiv:2503.05344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Thank you