Fujitsu Quantum Computing Strategy

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CTO and System Platform

Fujitsu Limited

April 20, 2025

Fujitsu Technology Strategy

FUJITSU

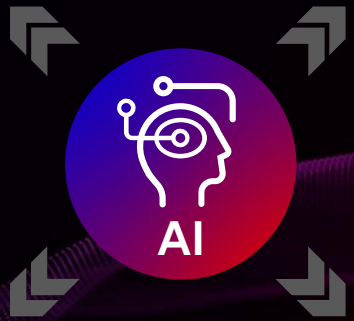
Differentiation through the fusion of AI and world-leading technologies

Quantum Computing

- Quantum
- Processor (FUJITSU-MONAKA)

Network

- Mobile：AI-RAN、Open RAN、vCUDU
- Photonics：APN
  800G/1.2T/1.6T Technology
- Software：Virtuora



AI Platform Kozuchi

- Generative AI framework for enterprises
- Large Language Model Takane

Data & Security

- Trustable Internet
- AI Security Framework
- Data Trust
- Ambient Auth.

Converging Technology

- Social Digital Twin
- Ocean Digital Twin
- Human behavior change Technology

Fujitsu Technology Strategy

FUJITSU

Differentiation through the fusion of AI and world-leading technologies

Quantum Computing

Investments in technology to achieve the world's fastest and most efficient computational technologies

Quantum

Quantum Computing
- 256 qubit (31st March 2025)
- 1,000 qubit (FY26)
- **Achieving fault-tolerant quantum computation** [FTQC] (FY26～)

Developing breakthrough technologies
- Diamond spin method
- STAR architecture

Processor: FUJITSU-MONAKA World's first 2nm server chip

AI Platform Kozuchi
- Generative AI framework for enterprises
- Large Language Model Takane

Network

- Mobile：AI-RAN、Open RAN、vCUDU
- Photonics：APN 800G/1.2T/1.6T Technology
- Software：Virtuora

Converging Technology

- Social Digital Twin
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Data & Security

- Trustable Internet
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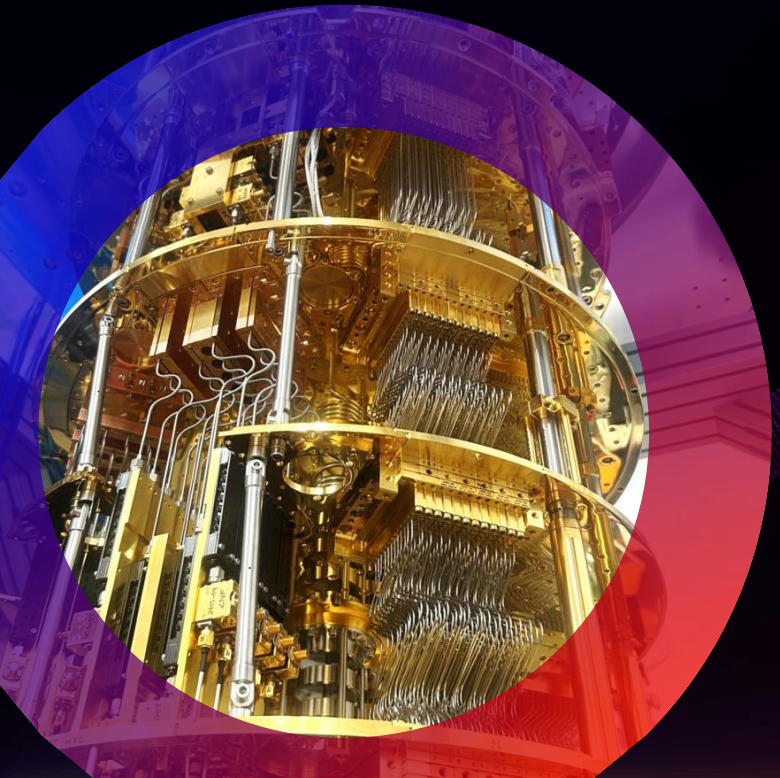
Developed 256-qubit quantum computer

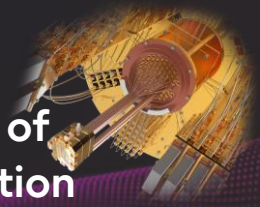
Crucial milestone for 1024 qubit and beyond

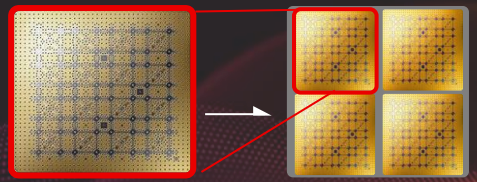


64 qubit → **256** qubit

Chip

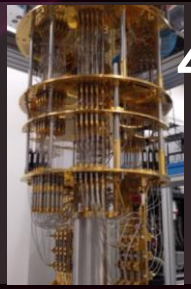
Proved usefulness of 3D connection structure



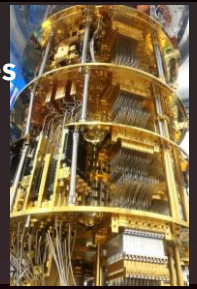


Inside dilution refrigerator

High density



4times High density

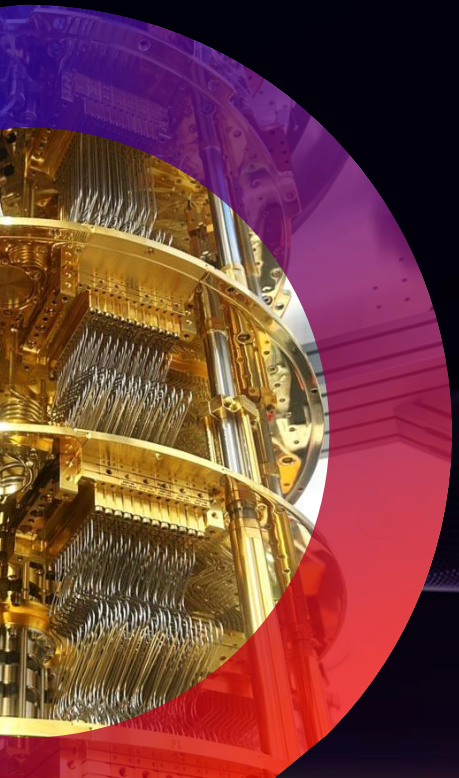


Developed 256-qubit quantum computer

FUJITSU

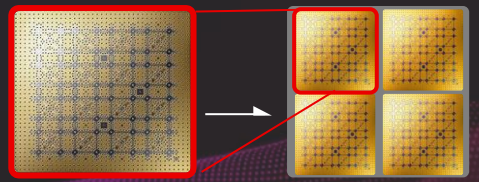
Crucial milestone for 1024 qubit and beyond

64 qubit → **256** qubit ----▸ **1024** qubit



Chip

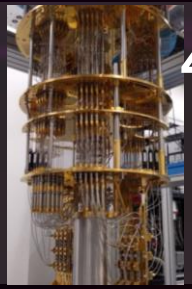
Proved usefulness of 3D connection structure



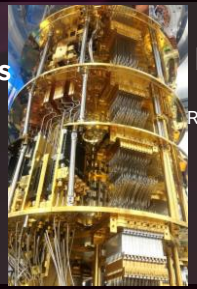
Scalable with 3D connection structure

Inside dilution refrigerator

High density



4 times High density



Increase Capacity, Refrigeration capacity

Expected to operate with increased volume and refrigeration capacity

Developed 256-qubit quantum computer

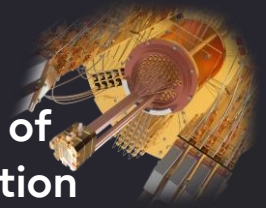
FUJITSU

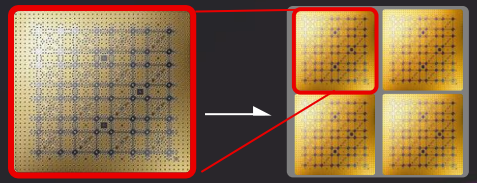
Crucial milestone for 1024 qubit and beyond

64 qubit → **256** qubit ----▸ **1024** qubit ----▸ beyond **1024** qubit

Chip

Proved usefulness of 3D connection structure

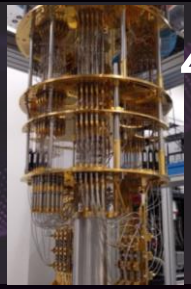




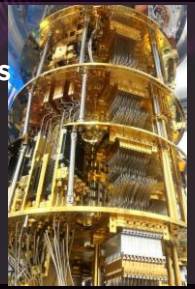
→ **Scalable with 3D connection structure** → **Level up of connection structure**

Inside dilution refrigerator

High density



4times High density →



Increase Capacity, Refrigeration capacity → **Expected to operate with increased volume and refrigeration capacity** → **Level up of high-density**

Roadmap of Fujitsu's quantum computer

FUJITSU

2022

Mar.
36-qubit quantum simulator

Sep.
39-qubit quantum simulator

2023

Mar.
Helped RIKEN release first Japanese domestic quantum computer

Jul.
40-qubit quantum simulator

2025

Oct.
64-qubit quantum computer from RIKEN RQC – Fujitsu Collaboration Centre

Mar
Released a **256**-qubit quantum computer with quantum-classical hybrid application framework

Fujitsu Quantum Building Completion (Sept)

1,024 qubit quantum computer will be unveiled

2026

Release a **1,024**-qubit quantum computer

2028

Release new quantum computing architecture for early-FTQC era

FUJITSU

Thank you

Development of World-Leading 256-Qubit Quantum Computer

Shintaro Sato

Fellow, Head of Quantum Laboratory
Fujitsu Research, Fujitsu Limited
Deputy Director
RIKEN RQC-Fujitsu Collaboration Center

April 22, 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.

RIKEN RQC-Fujitsu Collaboration Center

(since April, 2021)

Mission：To develop key technologies to realize quantum computing

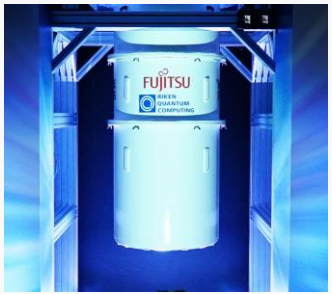
- To develop hardware and software technologies to realize a quantum computer with 1000 qubits
- To develop applications using a prototype quantum computer

The first phase of the Collaboratoin Center ended at the end of March 2025, and the second phase has begun in April.

Establishment of the Collaboration Center. Development of technology for 1000-qubit systems began.

April, 2021

Launch of Japan's second domestically produced 64-qubit quantum computer. Hybrid quantum platform provision began.



October, 2023

Today

Launch of 256-qubit quantum computer. Achieved 4x higher density integration.

2025

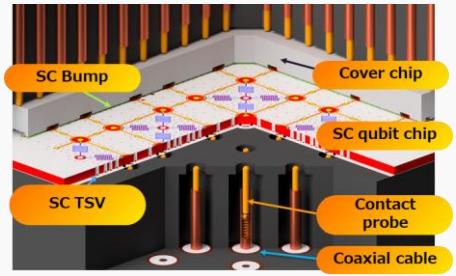
2025/04～ The second phase of Collaboration Center

Development of 256-Qubit System

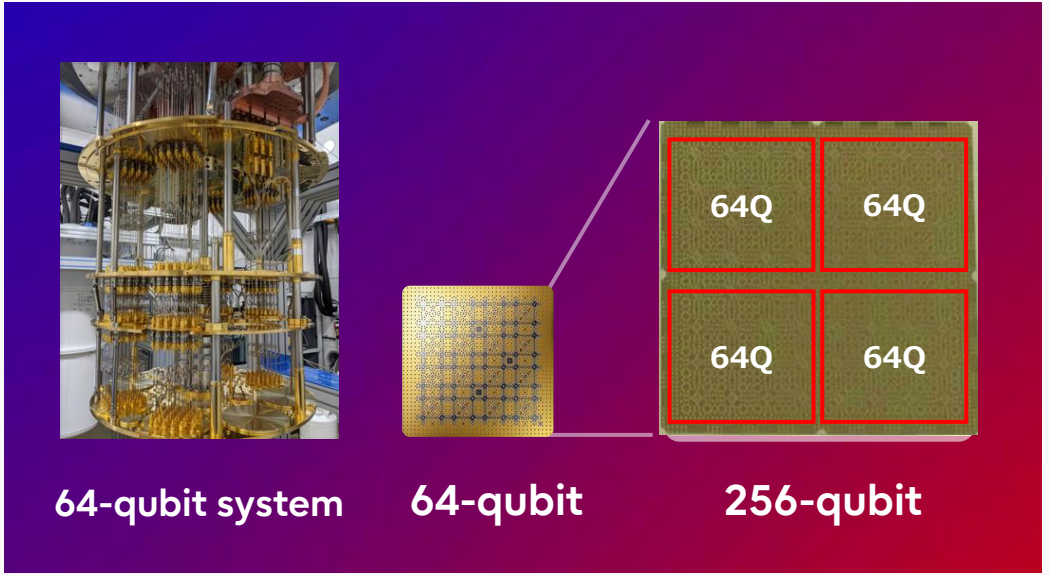
Challenge: Is it possible to achieve 4x higher density component integration in a refrigerator of the same size and capacity as that used for the 64-qubit system?

- Will all components fit within the refrigerator?
- Is it possible to cool down to cryogenic temperatures even with a 4x increase in component density?

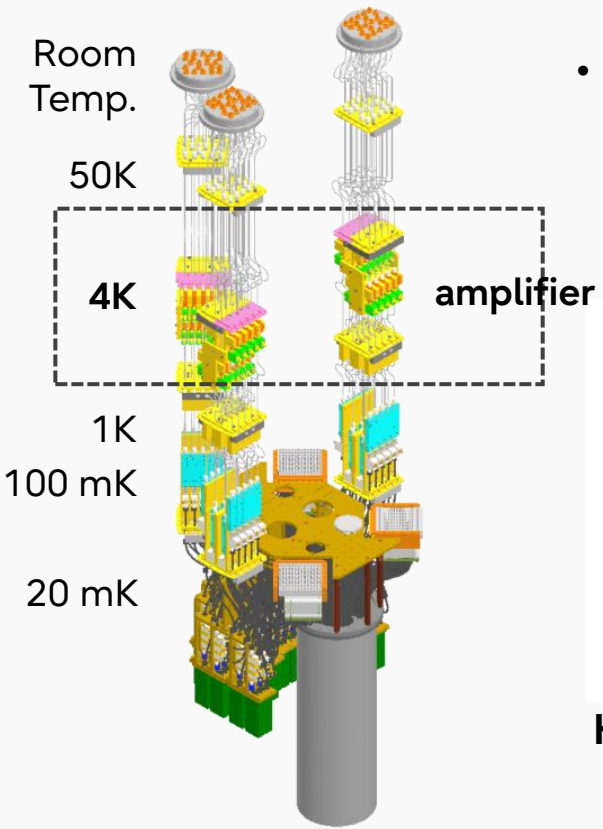
(approximately 20 millikelvin, -273.13 degrees Celsius)



Our qubit chip features a three-dimensional contact structure that is easily scalable.



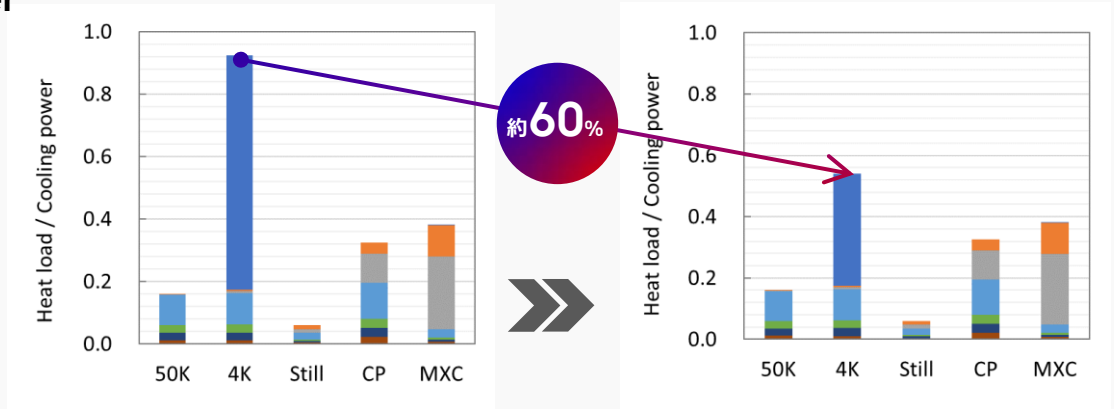
Thermal Design for Scaling Up Systems



- We have estimated the heat balance at each temperature stage within the dilution refrigerator.
- At the 4K stage, which is a bottleneck, we have selected amplifiers that generate less heat and implemented a housing design to improve cooling efficiency.

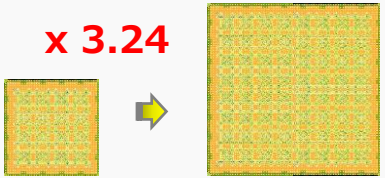
Design similar to 64-qubit system

New Desing



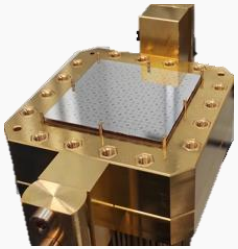
Heat balance at each stage within the dilution refrigerator (ratio of heat generation to cooling capacity)

Development of New Package



64Q chip (□20mm)

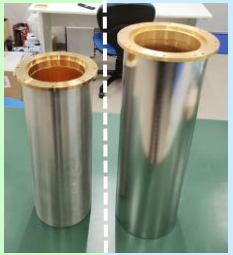
256Q chip (□36mm)



256-qubit chip

SMP connector

64Q



Package shield

256Q

Package
□40mm ⇒ □56mm (x 1.96)

# of cables
80 ⇒ 320 (x 4)

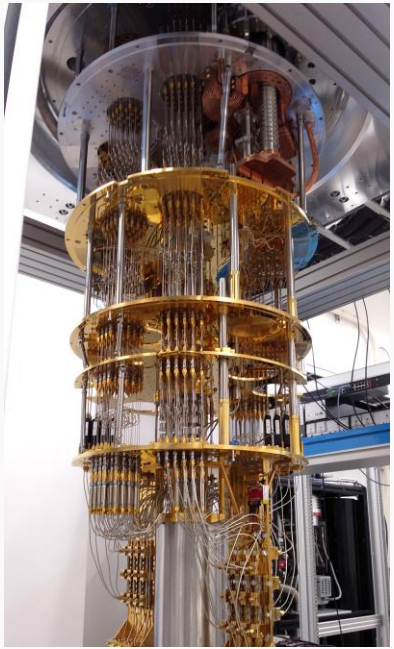
Height
363mm ⇒ 438mm (x 1.21)

Bottom plate
Φ111mm ⇒ Φ120mm (x 1.17)

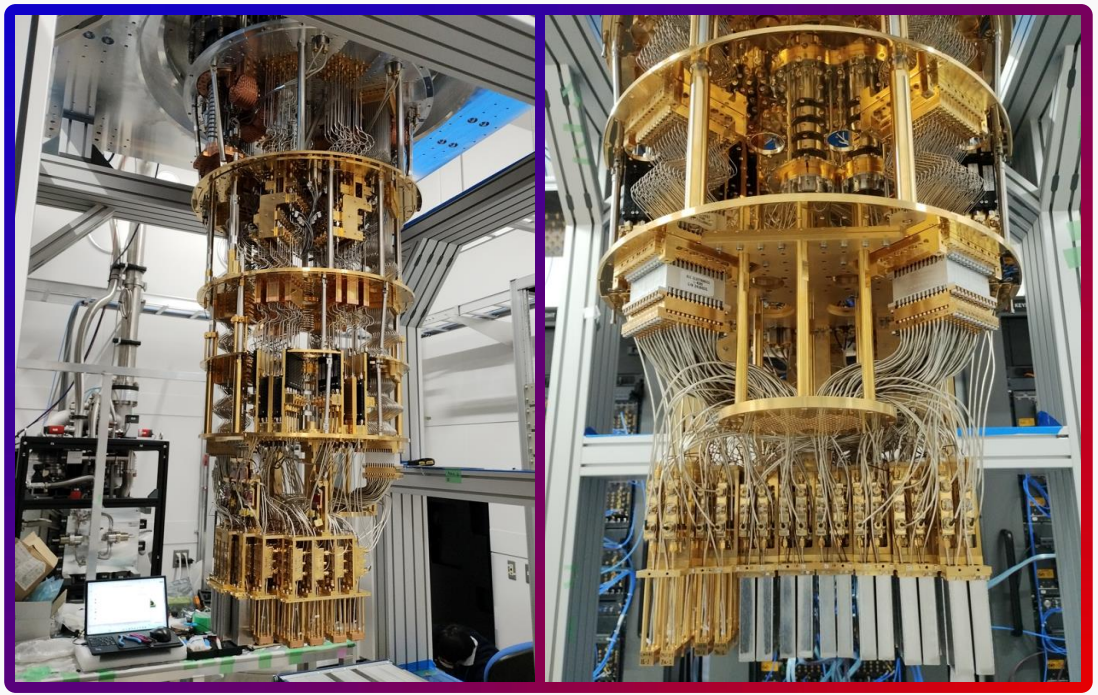
SMPM connector

High-Density Integration Technology

4x increase in component density within the dilution refrigerator



64-qubit system



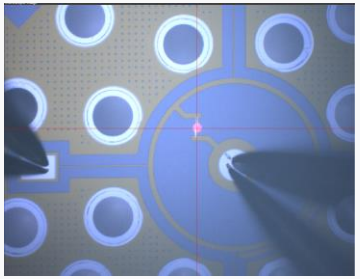
256-qubit system

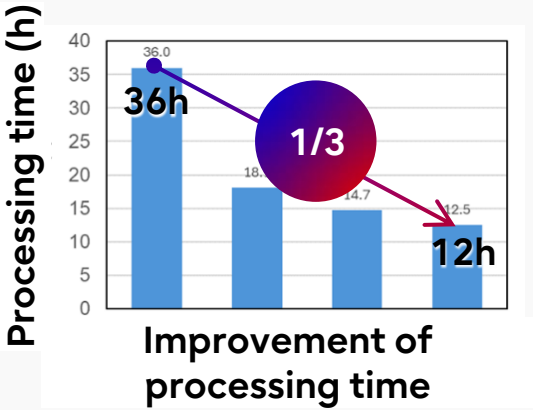
Technology for Improving Qubit Variability

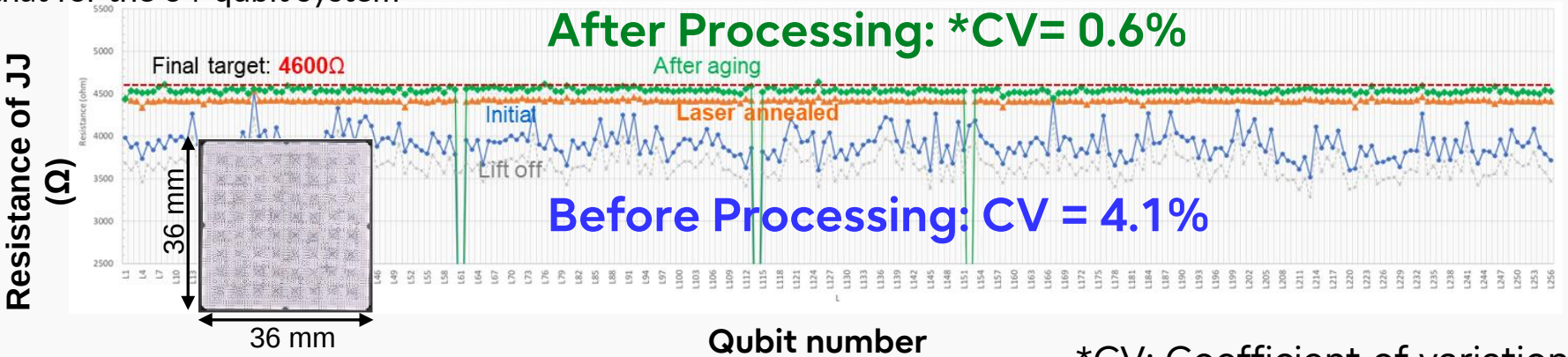
RIKEN QUANTUM COMPUTING

FUJITSU

- Developed a technology to individually fine-tune the resistance of Josephson Junctions (JJs) using laser irradiation.
- Improved the coefficient of variation in device resistance from 4.1% to 0.6% compared to before processing.
- The processing time has been also reduced to one-third of that for the 64-qubit system







*CV: Coefficient of variation

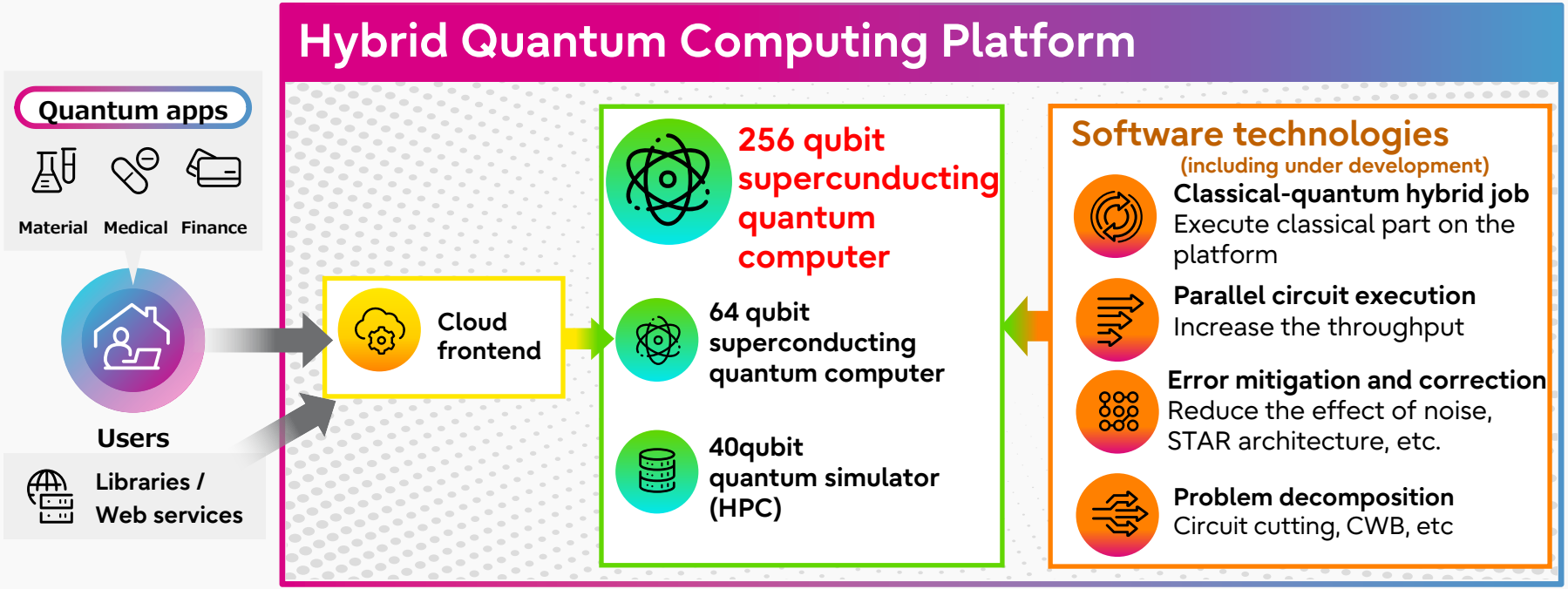
Developed 256-Qubit Quantum Computer

- Achieved the development of one of the world's largest-class quantum computers* through thermal design and high-density integration technology
- Planned Availability: During the first quarter of 2025.

*quantum computer available to external users

Hybrid Quantum Computing Platform

- The 256-qubit machine is now connected to the hybrid quantum platform.
- Developing new software technologies to make the most of the potential of the scaled-up quantum computers

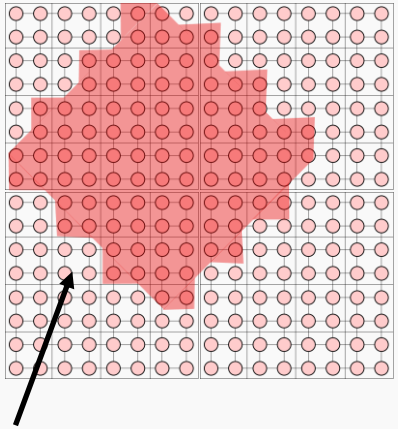


Future Plan: Experiments for Error Correction

Towards Fault Tolerant Quantum Computing

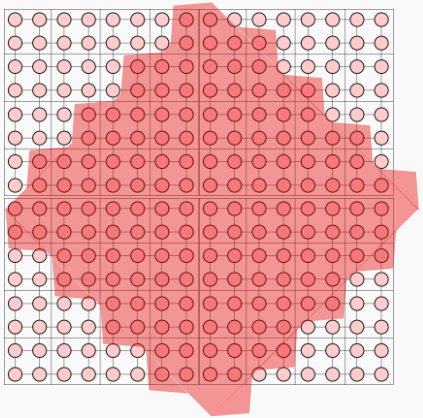
- Realization and performance evaluation of logical qubits and logical quantum gate operations (rotational surface code implementation up to code distance 7 is possible).
- Development of a quantum error correction system.

Code distance: 7



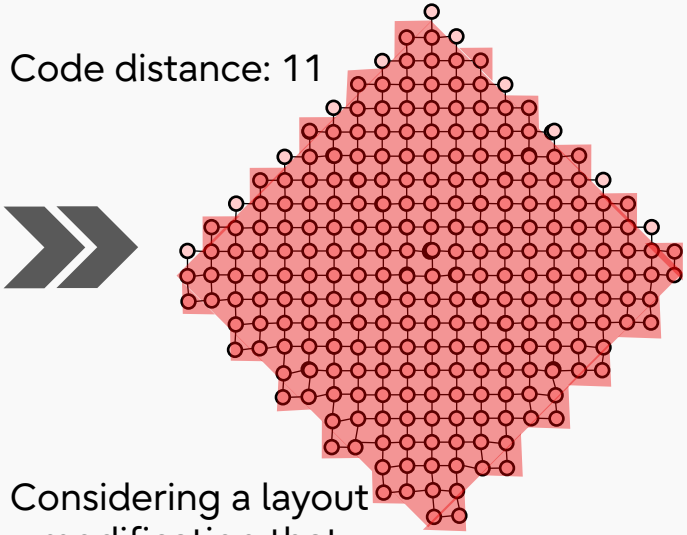
Logical qubit

Code distance: 9



Short of qubits

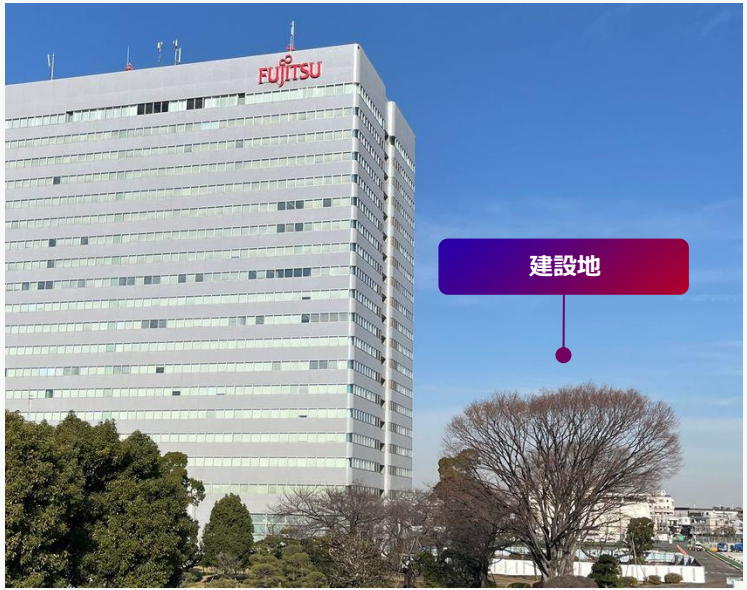
Code distance: 11



Considering a layout modification that could enable support for code distance 11.

Development of 1000-Qubit System

- We are currently constructing a facility for a 1000-qubit system at Fujitsu Technology Park.
- We are developing the 1000-qubit system and plan to make it available in fiscal year 2026.



Future Outlook

- In the first quarter of fiscal year 2025, we will begin offering a 256-qubit system to customers on a collaborative research basis through our hybrid quantum platform. Together with our customers, we will engage in the development of applications in fields such as materials science, drug discovery, and finance.
- We will conduct error correction experiments using the 256-qubit system.
- We will proceed with the development of a 1000-qubit system, aiming for its availability by fiscal year 2026, and will also conduct technological development towards systems exceeding 1000 qubits.

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Thank you