Fujitsu Quantum

Quantum Laboratory, Fujitsu Research

Fujitsu Limited

2026/1/27-29

FUJITSU

Computing Technologies for the Future

Application of Advanced Scientific Technologies

Data Analytics

Solving Social Issues

Quantum Computer

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Quantum Technology

Enterprise System

Digital Annealer

Quantum-Inspired Technology

FX10

Processor (FUJITSU-MONAKA, FUJITSU-MONAKA-X, …)

High-Performance Computing

FX1000

Processor Technology

Processor (A64FX)

Frequency Increase	Multi-Core		Many-Core	Memory-Centric
1990	2000	2010	2020	2030	2040

Fujitsu's Strategy for Quantum Computing

- 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

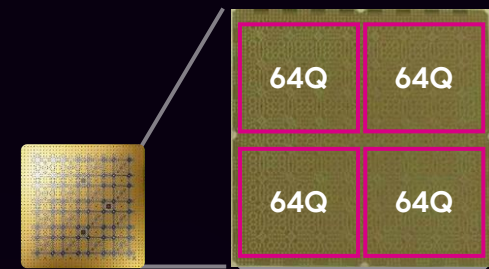| Quantum Application	Research with end-user input: 🧪 Materials | 💊 Drug discovery | 💳 Finance		FUJIFILM, TU Delft Tokyo Electron, etc.
Quantum Software	**QunaSys** Algorithm	**Keysight Technologies** Error Suppression	**The Univ. of Osaka** Error Correction
Quantum Platform	Middleware	Complier	Cloud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

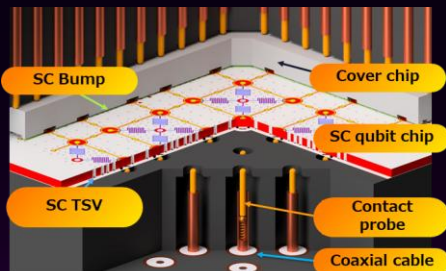# Superconducting Quantum Computers (64/256-qubit)

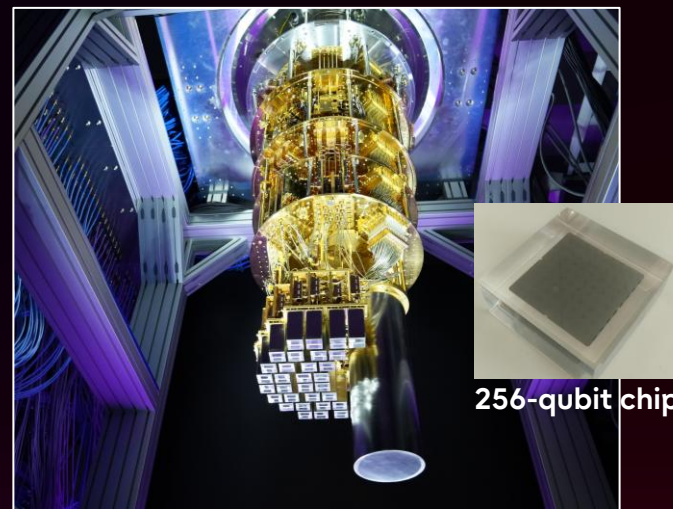• Developed at RIKEN RQC-Fujitsu Center with Prof. Nakamura
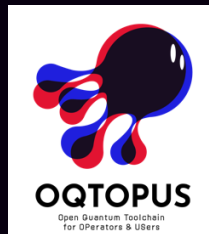

64-qubit

256-qubit

64-qubit system (Oct. 5, 2023)

https://pr.fujitsu.com/jp/news/2023/10/5.html

256-qubit chip

256-qubit system (April 22, 2025)

https://pr.fujitsu.com/jp/news/2025/04/22.html

OQTOPUS: Platform software as OSS

Open Quantum Toolchain for Operators and Users

- Full-stack quantum computing system including discussed features, operating across three layers

- Developed with Osaka Univ. https://github.com/oqtopus-team

Open sourse

Quantum Software

OQTOPUS Software Stack

| GUI | APIs+Plugin |

OQTOPUS Cloud

OQTOPUS Engine
| Server-side Execution Service | Multi-Programming Service |

| Quantum Control Software | Tranqu + Tranqu server | Q Dash |

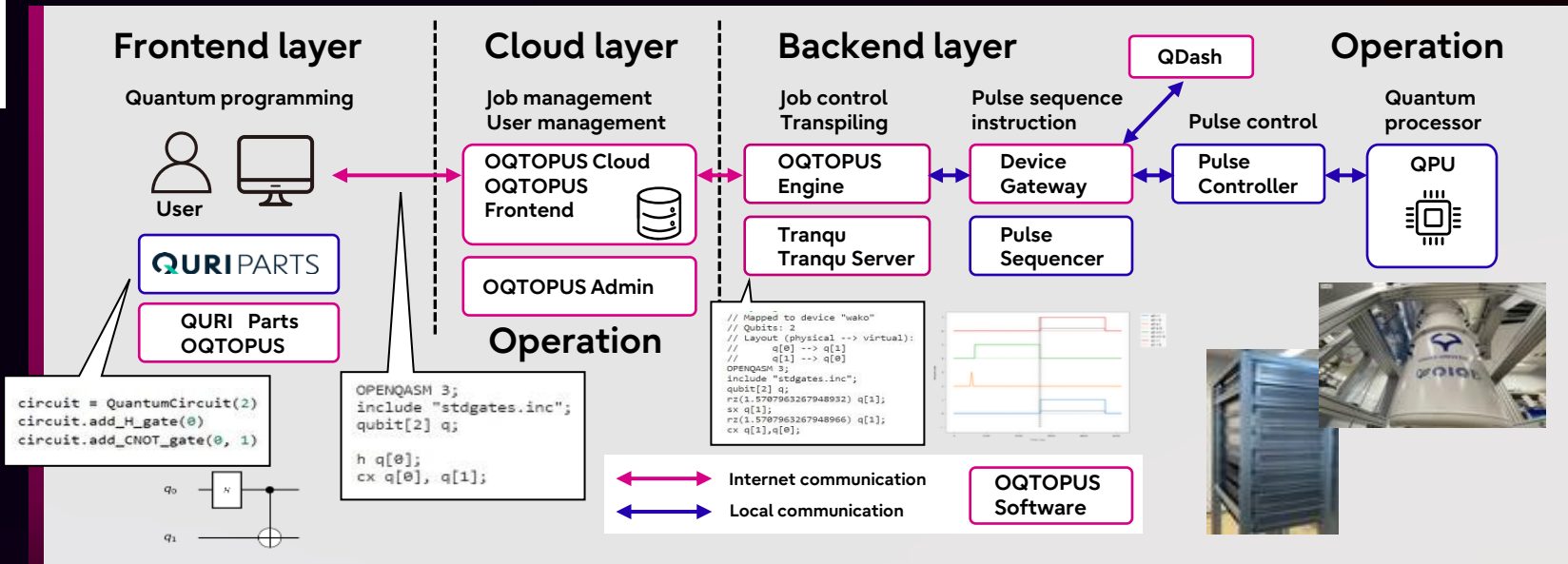**Quantum Control Hardware**

Controller

Quantum Processing Unit

Quantum Chip

OQTOPUS: Platform software as OSS

Open Quantum Toolchain for Operators and Users
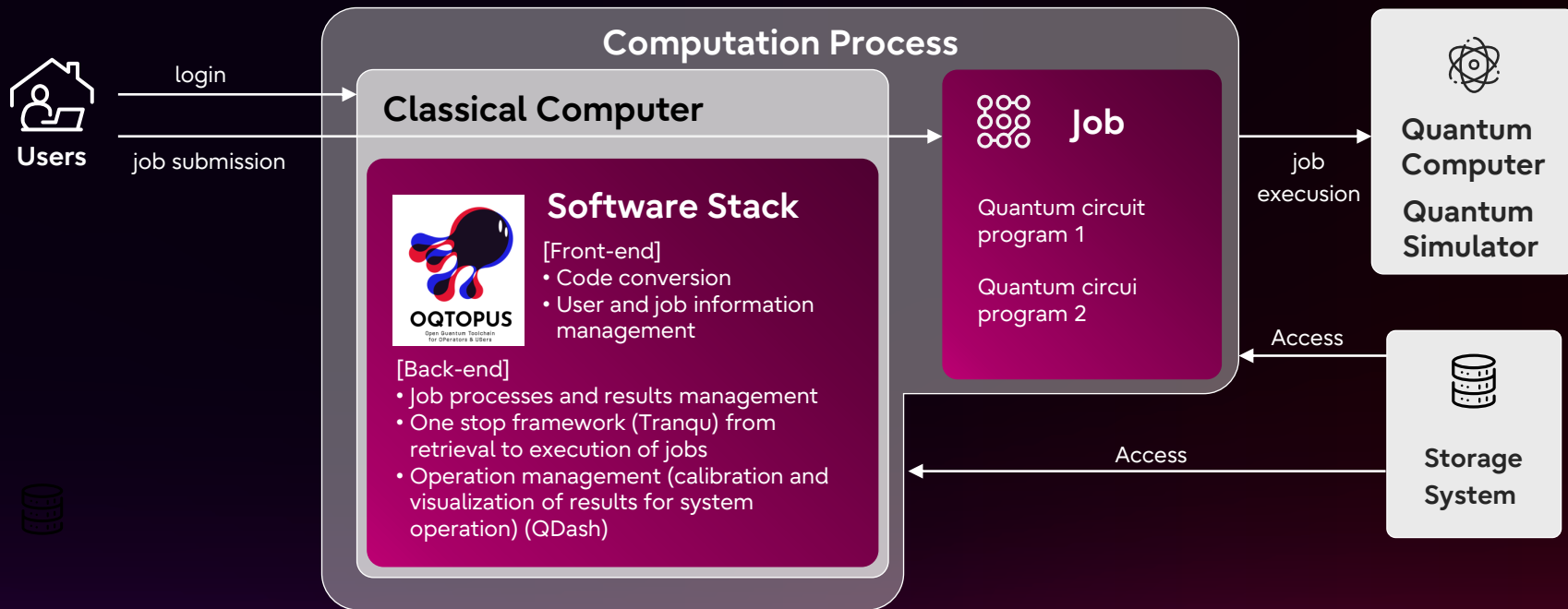

Please visit poster booth!

P-109: Optimization of Quantum Computer Throughput by Quantum Multi-Programming

P-115: Enhancing Quantum Computing Service Availability: A Multi-Region Architecture for Service-Level Fault Tolerance

Platform for Hybrid Quantum Computing

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- Seamless operations between quantum and classical computers
- Users can run jobs by logging in OQTOPUS on CPU nodes

Users

login

job submission

Computation Process

Classical Computer

Software Stack

OQTOPUS
Open Quantum Toolchain
for OPerators & Users

[Front-end]
- Code conversion
- User and job information management

[Back-end]
- Job processes and results management
- One stop framework (Tranqu) from retrieval to execution of jobs
- Operation management (calibration and visualization of results for system operation) (QDash)

Job

Quantum circuit program 1

Quantum circui program 2

job execusion

Quantum Computer

Quantum Simulator

Access

Storage System

Access

Use Cases Exploration with Companies and Universities

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Seeking breakthrough in quantum technology

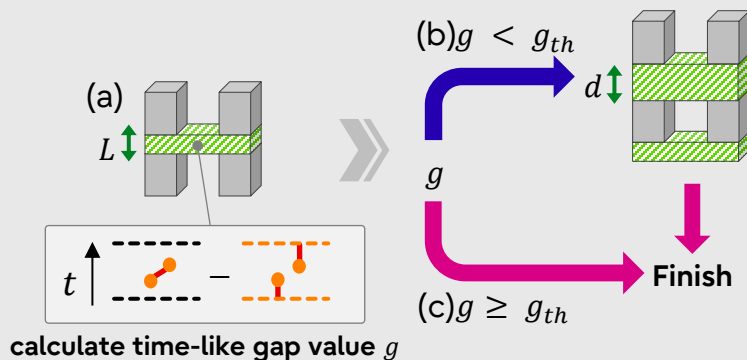| Materials	Drug discovery	Finance	Manufacturing	Machine
Fujifilm	**Mitsubishi Chemical Group**	**Mizuho-DL Financial Technology**	**AGC**	**Shibaura Institute of Technology**
Discover innovative materials through simulation	**Realize highly effective drugs with minimal side effects**	**Optimize and maximize efficiency in investment decisions**	**Utilize resources effectively to reduce environmental impact**	**Realize a humanoid that moves efficiently**
Increase speed/accuracy in organic molecule energy calculation by using variational quantum algorithms	Method to calculate the energy of macromolecules like proteins	Quantum machine learning algorithm for high-precision credit assessment	Quantum approximate optimization algorithm for glass plate cutting problem	Variational quantum algorithms for movement control of a multi-Joint robots

New Quantum Error Correction Technology

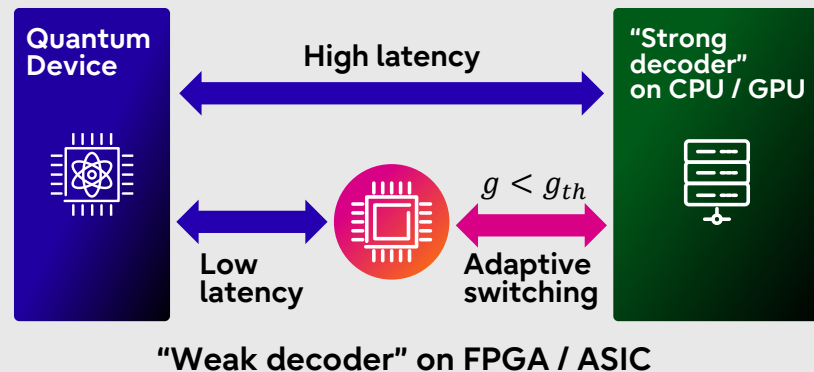Evolution of the STAR architecture

Succeeded in accelerating computation speed by more than double and reducing error occurrence probability to 1/6 or less

Acceleration based on temporal soft information

(a)

L

t calculate time-like gap value g

(b) $g < g_{th}$

d

g

(c) $g \geq g_{th}$

Finish

Increased the calculation speed by more than double, by switching the error detection cycle based on temporal soft information
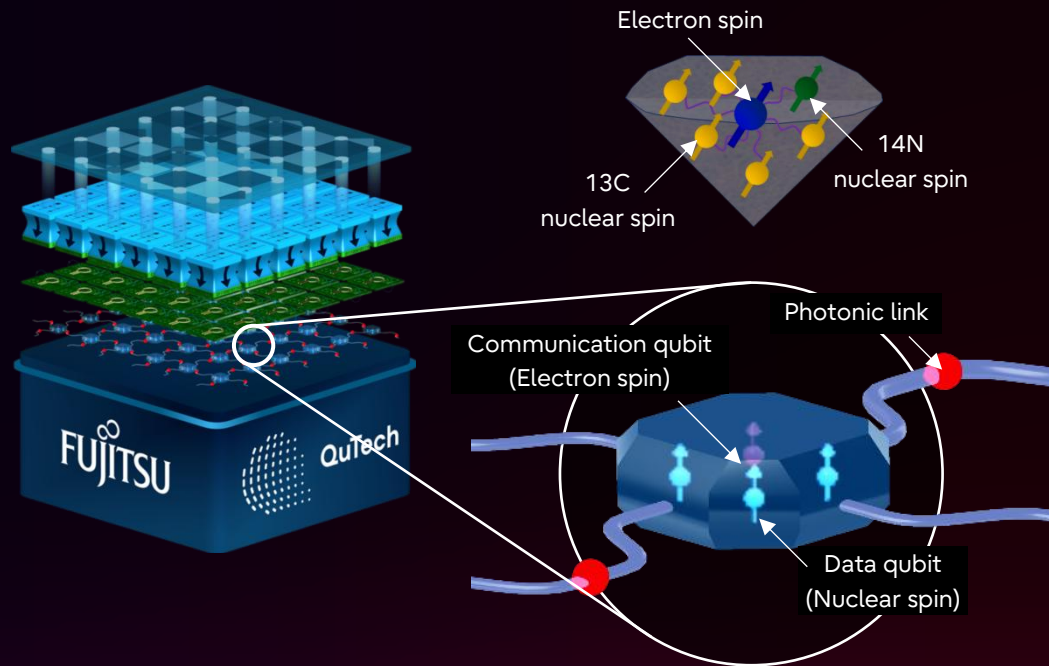
Error rate reduction through decoder switching

Quantum Device

High latency

"Strong decoder" on CPU / GPU

Low latency

$g < g_{th}$

Adaptive switching

"Weak decoder" on FPGA / ASIC

Adaptive switching of decoders reduced the error rate to 1/6 or less
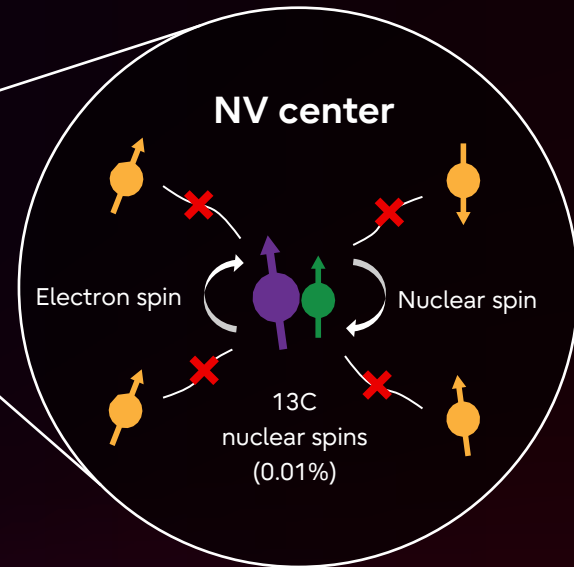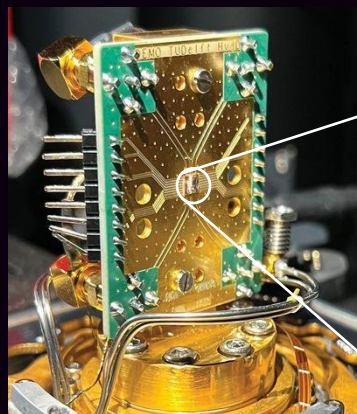
Diamond-Spin Qubit Technologies for Scalable Quantum Computer

- 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.

Electron spin

13C nuclear spin

14N nuclear spin

Communication qubit (Electron spin)

Photonic link

Data qubit (Nuclear spin)

High-Fidelity Quantum Gates in Diamond-Spin Qubits

- World's first demonstration of quantum gate operations for diamond spin qubits with an error probability below 0.1%.

- 2-qubit gate fidelity: > 99.9%
- 1-qubit fidelity (electron): > 99.99%
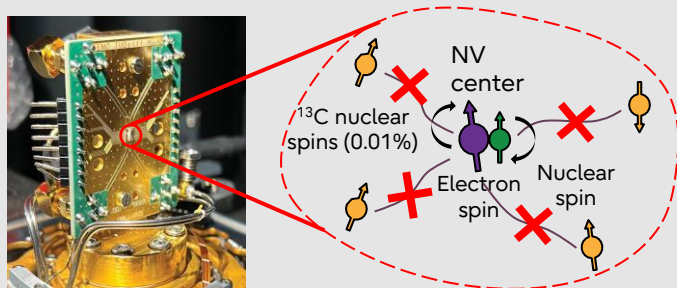 1-qubit fidelity (nuclear): > 99.999%, evaluated by gate-set tomography

NV center

Electron spin

Nuclear spin

13C nuclear spins (0.01%)

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

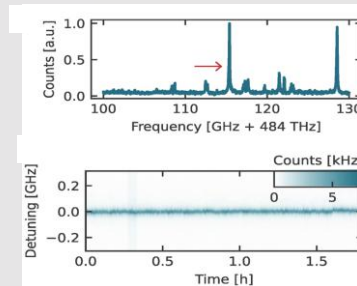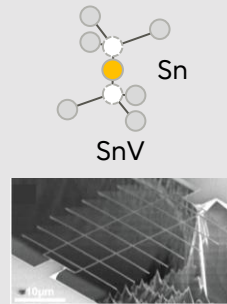https://www.fujitsu.com/global/about/resources/news/press-releases/2025/0324-02.html

Key Technologies for Scalability in Diamond-Spin Qubits
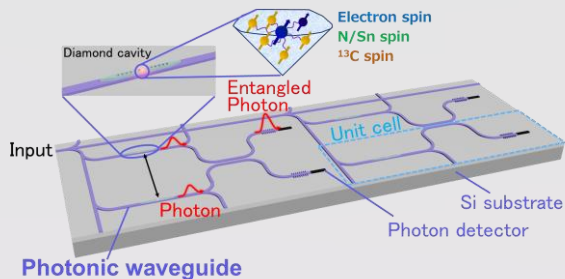
Qubit control technology for error correction

NV center

^{13}C nuclear spins (0.01%)

Electron spin

Nuclear spin

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

New material: SnV qubit for improving photonic link

Sn

SnV
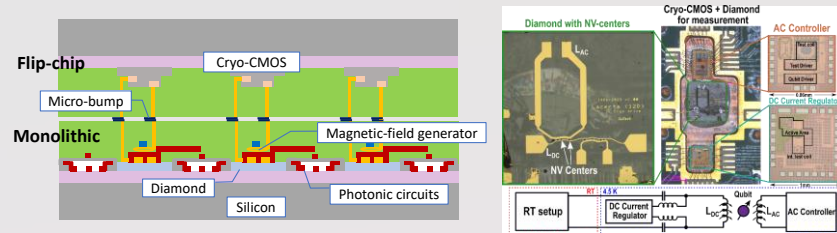
M. Pasini *et al.*, arXiv:2311.12927 (2023).

Photonic integration for scalable quantum photonic chip with diamond spins

Electron spin
N/Sn spin
^{13}C spin

Diamond cavity

Entangled Photon

Input

Unit cell

Photon

Si substrate

Photon detector

Photonic waveguide

3D integration and Cryo-CMOS for scalable quantum chip

Flip-chip

Cryo-CMOS

Micro-bump

Monolithic

Magnetic-field generator

Diamond

Silicon

Photonic circuits

Quantum Computer Simulator

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

- 40qubits Qulacs (state vector simulator) on FX700 cluster
- A MONAKA-based simulator will be launched

Collaboration with customers

- Material (Fujifilm), Finance (Mizuho-DL Financial Technology), etc
- Quantum challenge: Annual application discovery challenges, currently calling for participants!
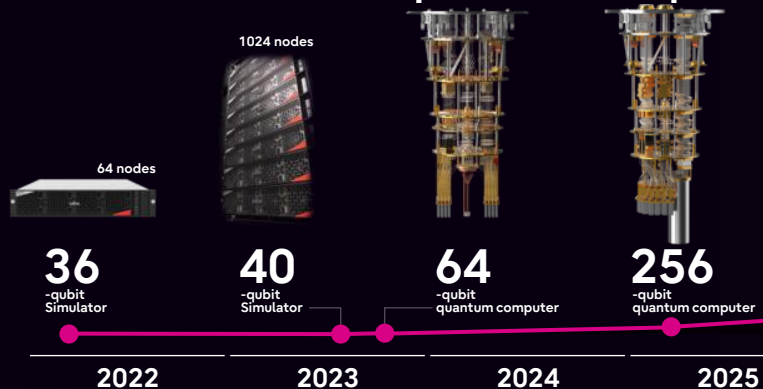
Research on new-type simulators for larger scale

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

Roadmap: Towards Practical Quantum Computing

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Superconducting quantum Computer

Aims to make practical quantum computing possible

1024 nodes

64 nodes

10,000+
-qubit quantum computer

250
-logical qubit

1,000
-logical qubit

36
-qubit Simulator

40
-qubit Simulator

64
-qubit quantum computer

256
-qubit quantum computer

1,024
-qubit quantum computer
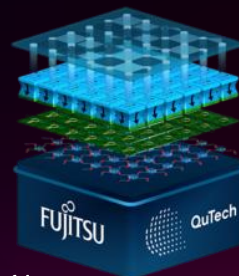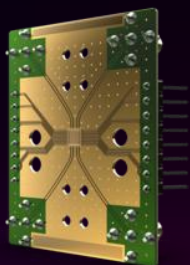
| 2022 | 2023 | 2024 | 2025 | 2026 | 2030 | 2035 |

Hybrid computing platform
Fujitsu's hybrid quantum computing platform offers users access to quantum computers and simulators for diverse applications
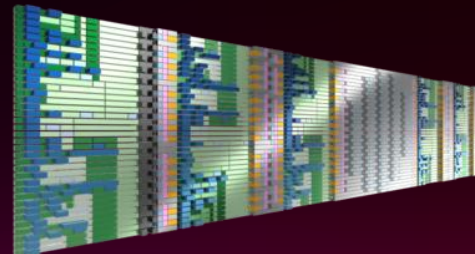
Diamond-spin quantum computer
World-first sub-0.1% error probability in diamond spin quantum gates marks important step toward practical quantum computing

STAR architecture
Establishment of high-speed execution method of practical algorithm using original quantum computing technology STAR architecture

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English

日本語

https://global.fujitsu/en-global/technology/research/quantum

Fujitsu Quantum Simulator Challenge

English

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https://global.fujitsu/en-global/technology/research/article/topics/2025 12-quantum-simulator-challenge