

## **Fujitsu and Osaka University Deepen Collaborative Research and Development for Fault-Tolerant Quantum Computers**

**Osaka University, Fujitsu Limited**

### **News Facts:**

- Osaka University and Fujitsu established the Fujitsu Quantum Computing Joint Research Division as a collaborative research program of the Center for Quantum Information and Quantum Biology (QIQB) of Osaka University
- The joint research division will combine QIQB's advanced quantum error correction and quantum software technologies with Fujitsu's applied knowledge in computing and quantum technologies to strengthen R&D in fault-tolerant quantum computing technology
- Fault-tolerant quantum computing, capable of accurate and large-scale high-speed calculations using quantum error correction codes offers potential to contribute to further progress in fields like drug discovery and finance

**Tokyo, October 1, 2021** – Osaka University and Fujitsu Limited today announced the establishment of the Fujitsu Quantum Computing Joint Research Division as a collaborative research division at the Center for Quantum Information and Quantum Biology (hereinafter QIQB) of Osaka University.

The newly-established research division will focus on the development of foundational technologies for fault-tolerant quantum computers, which are able to perform accurate calculations while correcting errors that occur in quantum bits (qubits). These efforts will draw on the respective strengths of the two partners, combining QIQB's advanced quantum error correction and quantum software technologies with Fujitsu's applied knowledge in computing and quantum technologies.

More specifically, QIQB and Fujitsu aim to develop quantum software for fault-tolerant quantum computers with up to several thousand qubits as well as technologies to verify its error correcting operations.

Going forward, the two partners will strengthen their cooperation in R&D towards the realization of fault-tolerant quantum computing technologies to innovate solutions to complex societal problems through quantum technology.

### **Background**

Quantum computers, which make use of the principles of quantum mechanics including quantum superposition states and quantum entanglement (Note 1), offer the potential to one day revolutionize computing, significantly exceeding the capabilities of conventional computing technologies to perform high-speed calculations.

Fault-tolerant quantum computing, capable of accurate and large-scale high-speed calculations using error correction codes, may become a key technology especially in the fields of drug discovery and finance, which require a technology able to solve complex and large-scale problems at high speed.

In March 2020, Osaka University established QIQB in order to promote quantum information and quantum biology research, focusing on research in a wide range of fields ranging from quantum computing, quantum information fusion, quantum information devices, quantum communications and security, quantum measurement and sensing, and quantum biology.

QIQB has also been chosen as the main center for quantum software research in the field of quantum technology of the COI-NEXT program (Note 2) of the Japan Science and Technology Agency (JST) and thus plays an important role in Japan's strategy for quantum technology innovation.

Cooperating with domestic and overseas research institutes, Fujitsu has been engaged in full-scale research and development of quantum computing since 2020, aiming to further improve the performance of computing technologies.

Leveraging its quantum-inspired computing (Note 3) solution "Digital Annealer", which is designed to solve large-scale combinatorial optimization problems, Fujitsu is providing customers solutions in various fields like drug discovery and logistics.

In October 2020, Fujitsu started collaborative research (Note 4) with Osaka University on quantum error correction. The establishment of the "Fujitsu Quantum Computing Joint Research Unit" will further strengthen R&D in fault-tolerant quantum computer systems.

#### **Outline of the Joint Research**

1. Name: Fujitsu Quantum Computing Joint Research Division
2. Location: Center for Quantum Information and Quantum Biology (QIQB), International Advanced Research Institute (IARI), Osaka University (Toyonaka City, Osaka Prefecture)
3. Research Period: October 1, 2021 to March 31, 2024
4. Research Contents: R&D of Quantum Software for fault-tolerant quantum computers

\*Assuming a quantum computer with a scale of several thousand qubits, the joint division will research and develop an error correction algorithm able to restore the original information from faulty qubits, as well as technologies to evaluate the performance of this algorithm.

\*In order to perform quantum computation using logical qubits (Note 5) generated through quantum error correction codes, the joint division will focus on the R&D and implementation of a set of software solutions required from program input to the result output.

With regard to future practical applications of this technology, the division will furthermore verify the operation of these solutions using a virtual machine environment to evaluate the effects of noise add up.

#### **Roles and Responsibilities**

##### **Osaka University**

- contribution to further R&D in the field of quantum error correction technology on a scale of several thousand qubits based on its knowledge of quantum error correction technology
- development of a set of software necessary for performing quantum computation using logical qubits and verify its application in a virtual machine

##### **Fujitsu**

- generation of quantum error correction algorithms for quantum computers on a scale of several thousand qubits based on its expertise in computing
- development of a set of software necessary for performing quantum computation using logical qubits; application of the software to a virtual machine and verification of its operation

#### **Future Plans**

In order to contribute to the further development of quantum computing science and technology, Osaka University and Fujitsu will strengthen their cooperation with a variety of research institutions and companies. Through the practical application of the results of this joint research, the partners aim to contribute to an early

practical application of quantum computing with the potential to drive innovations and create a sustainable society.

Osaka University and Fujitsu will also collaborate with related industries and the academia to support the training of new human resources in the field of quantum technology.

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#### Notes

**[1] Quantum entanglement:**

Quantum mechanical phenomenon of nonlocal correlations between two distant systems

**[2] COI-NEXT:**

Industry-academia collaboration program in which universities and other organizations take the lead in formulating a vision for a future society. The aim of this program is to promote ongoing research and development towards the realization of this vision, as well as to form an independent, collaborative unit of industry, academia and government members able to deliver results even after the completion of the project. In 2020, QIQB was chosen as an international research hub for policy focused areas (quantum technology) of the program. (Quantum Information and Quantum Life Research Center, Osaka University (QIQB) HP <https://qiqb.osaka-u.ac.jp/en/coi-next/>)

**[3] Quantum-inspired technology:**

A number of acceleration technologies inspired by quantum technology, but not quantum effects.

**[4] Joint research on quantum error correction:**

"Fujitsu Commences Joint Research with World-Leading Institutions for Innovations in Quantum Computing" (October 13, 2020 press release  
<https://www.fujitsu.com/global/about/resources/news/press-releases/2020/1013-02.html>)

**[5] Logical qubits:**

Qubits able to perform quantum logical operations without errors. Logical qubits are generated through the encoding of multiple qubits by a code able to correct quantum error codes.

#### About Osaka University

Osaka University was founded in 1931 as one of the seven imperial universities of Japan and is now one of Japan's leading comprehensive universities with a broad disciplinary spectrum. This strength is coupled with a singular drive for innovation that extends throughout the scientific process, from fundamental research to the creation of applied technology with positive economic impacts. Its commitment to innovation has been recognized in Japan and around the world, being named Japan's most innovative university in 2015 (Reuters 2015 Top 100) and one of the most innovative institutions in the world in 2017 (Innovative Universities and the Nature Index Innovation 2017). Now, Osaka University is leveraging its role as a Designated National University Corporation selected by the Ministry of Education, Culture, Sports, Science and Technology to contribute to innovation for human welfare, sustainable development of society, and social transformation. Website: <https://resou.osaka-u.ac.jp/en>

#### About Fujitsu

Fujitsu is the leading Japanese information and communication technology (ICT) company offering a full range of technology products, solutions and services. Approximately 126,000 Fujitsu people support customers in more than 100 countries. We use our experience and the power of ICT to shape the future of society with our customers. Fujitsu Limited (TSE:6702) reported consolidated revenues of 3.6 trillion yen (US\$34 billion) for the fiscal year ended March 31, 2021. For more information, please see [www.fujitsu.com](http://www.fujitsu.com).

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