# Quantum Software Research Hub (Osaka University)

# 1. Mission

The Quantum Software Research Hub aims to contribute to the social implementation of quantum computers by developing algorithms for fault-tolerant universal quantum computers, through the hybrid utilization of NISQ machines and classical computers, and by creating applications in a wide range of fields such as quantum AI and quantum chemistry.

# **2.** Activities

## **1** Quantum Software Research and Development

MEXT - Quantum Leap Flagship Program (MEXT Q-LEAP), Technology Area: Quantum information technology

CE Q B

Center for Quantum Information and Quantum Biology



### **Development of quantum software by intelligent** quantum system design and its applications

- Establishing the foundational theories of quantum computation and quantum AI (QAI)
- Identifying problems in finance and/or quantum chemistry, where there is expected to be a quantum advantage
- Applying QAI as a tool to chemistry and material science, and developing the research field of quantum  $\times$  informatics
- Designing middleware to improve the performance of quantum computers
- Applying existing noisy-intermediate scale quantum (NISQ) computers to practical problems

[Agency] Osaka Univ., Kyoto Univ., U Tokyo, NICT etc.

### **2** Formation of Open-Platform Research Centers

Funded by Japan Science and Technology Agency (JST) through "The program on open innovation platform for industry-academia co-creation (COI-NEXT)" Creating a sustainable future society by building a



MEXT Q-LEAP QuAI flagship

ΠH



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### quantum software development platform, promoting social implementation and dissemination, as well as establishing a platform for solving social problems.

- Develop a library for science and technology calculations such as machine learning and quantum chemistry
- Create the cloud environment and underpinning software for performing quantum computation
- Build test bed environments and control of quantum computer hardware -[Agency] Osaka Univ., Kyoto Univ., RIKEN, Fujitsu Limited, AWS and about 40 companies.

#### Research

✓ Proposed quantum circuit learning algorithm (QCL) (>1500 citations) ✓ "Current numbers of qubits and their uses", Nature Reviews Physics **6**, 345-347 (2024)





#### Development

- $\checkmark$  The first simulator in the world, Qulacs
- ✓ GUI Simulator, Qulacs Simulator
- ✓ Quantum machine learning library
- ✓ Quantum chemistry library
- ✓ Open Quantum Toolchain for **OPerators & USers, OQTOPUS**

#### **QUANTUM SOFTWARE RESEARCH HUB**



#### Eco-System Building

- ✓ Tours and hands-on experience with quantum computers in collaboration with QunaSys
- ✓ Quantum software information sessions for industry and students
- ✓ Future Forum at Umeda "Quantum" Town Edition"



Quantum machine learning using QCL

✓ QuEL, Received the Minister of Education, Culture, Sports, Science and Technology Award at Award for Academic Startups 2024



Founders of QuEL

- ✓ Symposium
  - "The Future of Quantum Computing"



Japan's third quantum computer at Osaka University