

Application R&D for Fault-Tolerant Quantum Computers

Project manager

(selected in 2025)

MITARAI

Kosuke

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 Associate Professor



Leader's institution

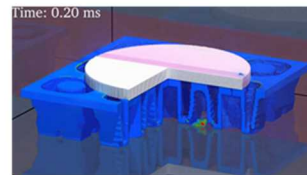
The University of Osaka

R&D institutions

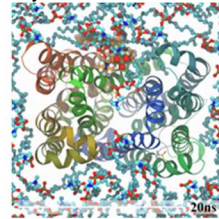
The University of Osaka, Tohoku University, The University of Tokyo, Nagoya University, Hosei University, Keio University, National Institute of Advanced Industrial Science and Technology, Mitsubishi Electric, Mizuho First Financial Technology

Summary of the project

We will promote application R&D for fault-tolerant quantum computers with a focus on computer-aided engineering (CAE) and computational materials science. We will also conduct exploratory research toward new applications such as machine learning. Beyond theoretical study, we will integrate algorithm design, compiler development, and implementation evaluation to quantify quantum advantage in the end-to-end applications required by users.



Katsumata et al., No. E-07-01, Proceedings of the 26th Conference on Computational Engineering and Science, 2021.

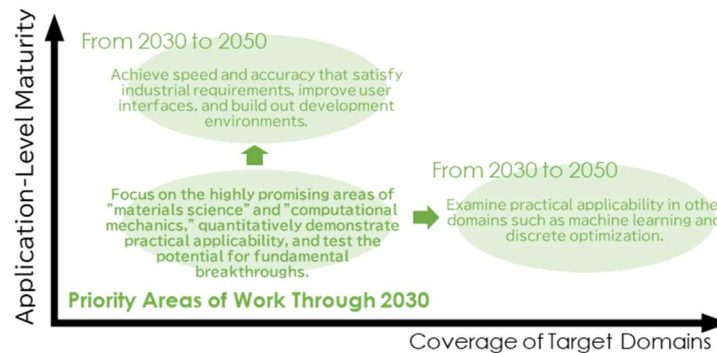


Milestone by the year 2030

By 2030, we will achieve at least one demonstration of end-to-end quantum speedup in a new application and quantify the required number of logical qubits and error-rate requirements.

Milestone by the year 2028

By 2028, across quantum CAE, computational materials science, and fundamental quantum algorithms, we will establish representative task workflows and resource evaluation frameworks, carry out theoretical verification of asymptotic quantum advantage, and define the prerequisites needed for a quantitative demonstration of quantum advantage by 2030.



Project structure

1. Quantum CAE Team (Leads: Terada / Endo)

- [1-1] Quantum acceleration for nonlinear structural analysis and elastic wave problems [Kenjiro Terada]
- [1-2] Fluid computation and physics-informed models that realize quantum acceleration [Kentaro Yaji]
- [1-3] Quantum acceleration for optimization, inverse analysis, and topology optimization [Junji Kato, Yoshihito Yamamoto]
- [1-4] Quantum acceleration for microstructure evolution simulation of materials and inverse estimation of microstructures [Mayu Muramatsu]
- [1-5] Core algorithms and end-to-end technologies for quantum CAE [Katsuhiro Endo, Tomonori Fukuda, Masafumi Kadowaki]

Know-how Sharing / Joint Research

2. Computational Materials Science Team (Leads: Mizukami / Yoshioka)

Resource estimation from real-world problems and feedback on issues

3. Core Algo Team (Lead: Mitarai)

- [3-1] R&D of core methods for resource reduction [Kosuke Mitarai]
- [3-2] Exploratory R&D aimed at expanding the application areas of quantum computing [Koichi Miyamoto, Hayata Yamazaki, Naoyuki Takeda]

Provision of core algorithms and subroutines

Resource estimation from real-world problems and feedback on issues

Provision of core algorithms and subroutines