# Large-scale and high-coherence fault-tolerant quantum computer with dynamical atom arrays

Project manager

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R&D institutions

Institute for Molecular Science, National Institutes of Natural Sciences, Kyoto University, RIKEN, Hitachi, Ltd.

## Summary of the project

We will implement a dynamic qubit array that performs gate manipulation, error detection and correction while quickly and independently moving each of the cold-atom qubits using optical tweezers. Furthermore, all components will be integrated and packaged under close collaboration between industry and academia to achieve unprecedented stability and usability. Through these innovations, we aim to realize a fault-tolerant quantum computer that will revolutionize the economy, industry, and security by 2050.

## Milestone by year 2030

Realize an operative, large-scale, cold-atom quantum computer with quantum error detection and correction capabilities.

## Milestone by year 2025

Generate entanglement between qubits and develop a non-destructive measurement technique for quantum error detection in a two-dimensional atomic array that can operate as qubits.

## R&D theme structure of the project

Each research direction and their teams are shown in the figure below. The most suitable proponents were brought together from a wide range of fields in industry and academia. In the execution of each proposal, it is anticipated that development will proceed while the respective constraints, progress, and results will strongly influence each other, so we did not necessarily assign a single investigator for each item independently, but rather organized multiple development units, which will proceed with collaborative R&D as necessary.

The Cold-Atom Unit, which covers Proposals 1-3, brings together Japan's top researchers in cold-atom experiments from the Institute for Molecular Science, Kyoto University, and RIKEN. In the Hardware Development Unit, as part of our close collaboration between industry and academia, we are joined by a team from Hitachi, Ltd. and ColdQuanta, Inc. d.b.a. Infleqtion led by a project investigator, and we collaborate with Hamamatsu Photonics. The Laser Development Unit is a joint team of a top laser development researcher and a cold-atom experimentalist. For the development of the quantum error detection and correction architecture, the team will work closely with Keisuke Fujii of the Koashi Project.

## Research Subjects and Team Composition