

Development of scalable Silicon quantum computer technology

Project manager

(selected in 2022)

TARUCHA Seigo

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Leader's institution

RIKEN

R&D institutions

RIKEN, Osaka University, Nagoya University, The University of Tokyo, Kobe University

Summary of the project

This project aims to develop scalable multi-qubit devices toward realization of Silicon quantum computer. We will use sparse integration and medium-distance quantum coupling to implement a unit structure of qubits and scale up the qubit system by integrating the unit structures. Based on this method we will develop technology bases appropriate to implement large-scale quantum computers by 2030, and expand them in cooperation with the semiconductor industry to realize universal quantum computers by 2050.

Milestone by year 2030

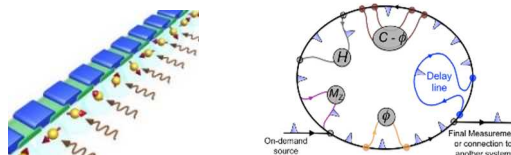
We establish technology bases for fabricating multi-qubit devices toward development of large-scale quantum computers in cooperation with semiconductor industries. In parallel, we perform characterization and high-fidelity quantum operation of the multi-qubit devices, design quantum channels suitable for the quantum links, and produce large-size high-quality silicon substrates, and in addition, demonstrate the principles of quantum phase error correction.



Qubit transfer channel

Milestone by year 2025

We use high-quality substrate of silicon/silicon-germanium (Si/SiGe) to establish fabrication technologies for implementing multi-qubit devices with a one-dimensional qubit array as a fundamental structure, and use them to construct a prototype of small- to middle-scale quantum computers. In addition, we inspect new principles for quantum gate circuits constructed by electron wave packets as propagating qubits.



One-dimensional qubit array (left); Quantum gate circuit with electron wave packets as qubits (right).

Project structure

Seigo Tarucha, PM

Development of scalable fault-tolerant Si qubit devices
 Takashi Nakajima, RIKEN
 Takuji Miki, Kobe University * *From April 2024

Development of middle-distance quantum link
 Takafumi Fujita, Osaka University

Development of isotopically controlled Si/SiGe substrate technology
 Satoru Miyamoto, Nagoya University

Development of electron wave-packet qubits with new principle
 Michihisa Yamamoto, RIKEN, The University of Tokyo
 Shintaro Takada, Osaka University

Si qubit device and the device operation setup: control electronics and a dilution refrigerator.

