Usage Report for Fiscal Year 2024

Project Title: Fidelity Limitations in Silicon Qubits

Name:
○ Leon Luca Caspar Camenzind (1), Juan Sebastian Rojas Arias (2), Yi-Hsien Wu (3)
(1) Center for Emergent Matter Science (CEMS), Quantum Functional System Research Group
(2) Center for Emergent Matter Science (CEMS), Semiconductor Quantum Information Device Theory Research Team
(3) Center for Emergent Matter Science (CEMS), Quantum Functional System Research Group

1. Background and purpose of the project, relationship of the project with other projects

The project aims to leverage the HBW2 supercomputer to analyze Gate Set Tomography (GST) data, focusing on improving gate fidelity and reducing the number of physical qubits required for a scalable, fault-tolerant quantum processor. By analyzing GST data, we can identify and mitigate systematic Hamiltonian errors, which is crucial for enhancing the overall performance and reliability of our quantum processors.

2. Specific usage status of the system and calculation method

A python package was used (pygst) to calculate the GST results.

3. Result

We successfully obtained the analyzed Gate Set Tomography (GST) results using the HBW2 supercomputer for two-qubit systems. This analysis, which is computationally intensive, provided precise characterization of quantum gates and valuable insights into their performance and their error sources.

4. Conclusion

The project successfully used the HBW2 supercomputer to analyze Gate Set Tomography (GST) data, enhancing our understanding of gate fidelities and identifying factors limiting performance. This analysis provided valuable insights into systematic and stochastic Hamiltonian errors, contributing to ongoing efforts to improve quantum processor reliability and scalability.

5. Schedule and prospect for the future

We plan to continue utilizing the supercomputer for our ongoing Gate Set Tomography (GST) analysis. Additionally, we aim to integrate GST simulations to deepen our understanding of the results and enhance data interpretation. For the future, we are also considering developing a simulation framework to better align our simulations with the real-world physical environment, further advancing our research capabilities.

Fiscal Year 2024 List of Publications Resulting from the Use of the supercomputer

[Paper accepted by a journal]

[Conference Proceedings]

[Oral presentation]

Yi-Hsien Wu, 99.99% Fidelity Simultaneous Single-Qubit Driving via Pulse Shaping, Basel-RIKEN Symposium 2024

[Poster presentation]

Yi-Hsien Wu, Benchmarking Single-Qubit Gate with 99.99% Fidelity via Pulse Shaping in a Five-Qubit Spin Qubit Device, Swiss Japanese Quantum Symposium 2024

[Others (Book, Press release, etc.)]