**Simulation of a flip-chip architecture of superconducting quantum processor**

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**Abstract**

Flip-chip technology is important in scaling up the quantum processor since it allows flexible wiring among components and designing of chips as it becomes three-dimensional architecture. Whereas a standard quantum chip contains qubits and resonators at the same time, a flip-chip structure has 2 separate chips each of which contains different components depending on the purpose. In this letter, the flip chip module consists of two chips, the quantum chip and the control chip, which face each other at a certain distance. The quantum chip hosts quantum circuitry which contains the Josephson junction and the control chip hosts resonators.

Controlling the capacitive coupling in the standard in-plane chips is easy since all the structures are set through one process. However, as the capacitive coupling of a flip-chip depends on the distance between the chips, it is important to design the flip-chip at a fabrication possible level.

In this presentation, we report the simulation results of the flip-chip to see the difference in target parameters according to the distance between the two chips. We simulate various parameters of flip-chip structure such as qubit transition frequency, readout resonator frequency, and the coupling strength between a qubit and a readout resonator. We investigate electric field distribution and the coupling strength depending on capacitive pad size and flip-chip distance. Finally, we compare the parameters of the standard quantum processor with our flip-chip structure.

Keywords: Superconducting qubit, Flip-chip, Simulation