Effect of Long-Range Crosstalk Errors on the Rotated Surface Code

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Crosstalk errors – due to unintended interactions between qubits and coupling between different circuit elements – pose a challenge to quantum error correction. They are often assumed to only affect nearest or next-nearest neighbour qubits [1], but experiments on single qubit drive line and coupler drive line induced crosstalk on superconducting quantum processors [2,3] show that they can occur between more distant qubits as well. In this work, we study the effect of longer-range crosstalk errors caused by the single qubit drive lines on the rotated surface code using numerical models – Clifford simulation – with realistic parameters of superconducting chips.

We use a square pulse envelop for the drive signal and assume an exponential crosstalk suppression to construct an approximate Pauli error model. We use the Pauli error models to simulate the effect of the crosstalk both on the threshold and the logical error rate below threshold, and compare the impact on threshold with that of the SI1000 model of circuit level error [4].

References

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Figures

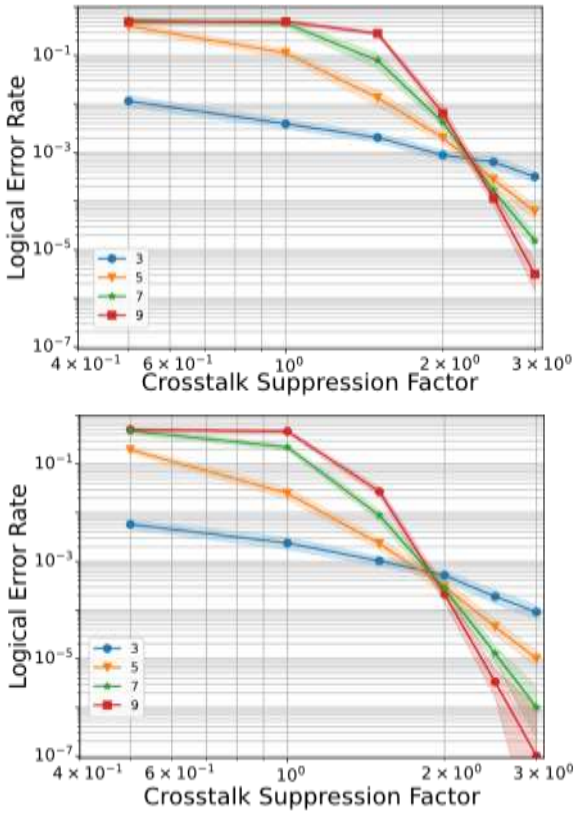

Figure 1: The effect of crosstalk on logical error rate in the absence of any noise: (top) for Z-memory and (bottom) for X-memory experiments. With the assumption of an exponential crosstalk suppression, a threshold is approximately 1.9 mm^{-1} - 2.1mm^{-1} based on experiments on distance 3-9.