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Qubit as an on-chip quantum probe of control distortions and temperature

Physical qubits are prone to various sources of errors. Imperfect control lines lead to gate infidelities, non-zero effective temperature leads to improper initialization of qubits' states, coupling to spurious unwanted two-level systems cause both. Characterization of these imperfections and distortions becomes imperative to progress towards real-world applications and breaking the error-correcting threshold for current noisy intermediate-scale quantum processors.

Using external sensors for that purpose may not always yield accurate results. For example, the effective temperature of a qubit $T_{\mbox{eff}}$ is known to be different from the reading T_{base} of a base stage temperature sensor of a dilution cryostat. In this talk I am going to describe a set of tools we have developed to employ a qubit itself as a probe of the transfer functions of control lines and an effective qubit temperature. We also show how these set of tools can provide useful information about origin of these errors and how to use the results to improve the fidelity of entangling gates.