Contribution ID: **20** Type: **01** - 分会报告

# Direct evidence for cosmic-ray-induced correlated errors in superconducting qubit array

*Friday 10 May 2024 14:00 (20 minutes)*

Correlated errors can significantly impact the quantum error correction, which challenges the assumption that errors occur in different qubits independently in both space and time. Superconducting qubits have been found to suffer correlated errors across multiple qubits, which could be attributable to ionizing radiations and cosmic rays. Nevertheless, the direct evidence and a quantitative understanding of this relationship are currently lacking. In this work, we put two cosmic-ray muon detectors directly beneath the sample box in a dilution refrigerator and successfully observe the correlated errors in a superconducting qubit array triggered by muons through monitoring multi-qubit simultaneous charge-parity jumps and bit flips. By introducing a lead shielding layer on the refrigerator, we reveal that the majority of other correlated errors are primarily induced by gamma rays. Furthermore, we find the superconducting film with a higher recombination rate of quasiparticles used in the qubits helps reduce the duration of correlated errors. Our results provide experimental evidence of the impact of gamma rays and muons on superconducting quantum computation and offer practical insights into mitigation strategies for quantum error correction. In addition, we observe the average occurrence rate of muon-induced correlated errors in our processor is approximately 0.40 $\text{min}^{-1}\text{cm}^{-2}$ which is comparable to the muon event rate detected by the muon detector with 0.506 $\text{min}^{-1}\text{cm}^{-2}$. This demonstrates the potential applications of superconducting qubit arrays as low-energy threshold sensors in the field of high-energy physics.

## Collaboration (if any)

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**Session Classification:** 09 - 探测器物理与技术

**Track Classification:** 09 - 探测器物理与技术