Fault-tolerant quantum computing with photonics

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1. Abstract

Quantum computing promises speedups across a range of computational disciplines, the most compelling of which is arguably computational chemistry and materials science. However, realizing these computational advantages typically requires quantum computers with orders of magnitude more qubits, and the capability of applying orders of magnitude more operations, than current devices can muster. This capability has two necessary predicates: (a) the need for manufacturable and scalable hardware; and (b) the need for *fault-tolerant quantum computing*, or *FTQC* (that is, the suppression of physical errors by quantum error correction).

Singularly for a quantum computing company, these predicates were at the foundation of PsiQuantum and are our sole focus. Specifically, PsiQuantum: builds scalable hardware for FTQC based on silicon photonics; designs and optimizes architectures to yield the most compelling path to fault-tolerance; and develops quantum algorithms that best exploit the unique nature of quantum computing with photons.

The goal of this talk is to twofold: to summarize PsiQuantum's path to fault-tolerance; and to highlight the advantages afforded to us in designing quantum algorithms around a photonic quantum computing platform. In particular, the ability to both route and store photons cheaply with optical fiber yields a flexibility in quantum algorithm design that is difficult to achieve with other hardware platforms, and often gives speedups that are unique to FTQC with photonics.