A scalable local addressing system for optically addressable qubits using integrated photonics

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Abstract

Among the leading approaches to scalable quantum computers are systems made of optically addressable qubits, such as neutral atoms, trapped ions and solid-state emitters. In these platforms, quantum information is typically manipulated using optical fields, so that scaling to large systems demands a high channel-count, high-speed, and precise optical modulators at low incremental cost. Existing solutions are not practical beyond a few tens of channels, limiting the number of independent degrees of freedom in the quantum computer. Here we present a Photonic Control Unit (PCU) that enables scaling of the number of local addressing beams using integrated photonics. Using the PCU, we experimentally demonstrate high-speed, high-extinction modulation and multi-channel operation, supporting the visible to near-infrared wavelength range, therefore meeting the precision, power, and wavelength requirements of quantum computing applications. We outline the route to achieving hundreds to thousands of channels for scalable optical control of qubits.