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Engineering periodic boundary conditions with circuit cutting for high-energy physics

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Quantum computers process information with the laws of quantum mechanics. Current quantum hardware is noisy, can only store information for a short time and is limited to a few quantum bits, that is, qubits, typically arranged in a planar connectivity. However, many applications of quantum computing require more connectivity than the planar lattice offered by the hardware on more qubits than is available on a single quantum processing unit (QPU). Circuit cutting is a promising tool to engineer long-ranged interactions and break quantum circuits into smaller components. In this talk I will present recent advances in circuit cutting such as coupling quantum processors with a real-time classical link [1]. I will discuss how these advances relate to our vision of quantum centric supercomputing. Finally, I will show how to simulate lattice Gauge theories with periodic boundary conditions on superconducting qubit QPUs. Here, the periodic boundary conditions are created with circuit cutting to avoid costly swap gates.

[1] Vazquez et al., Combining quantum processors with real-time classical communication, Nature (2024).

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Short summary

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