

Title: From Foundries to Frontlines: Scalable Quantum Technologies through Automation and Algorithmic Resilience

Abstract:

Realizing the potential of quantum technology requires more than advances in algorithms or hardware; it demands a practical strategy to transform fragile quantum devices into scalable, reliable systems. At Q-CTRL, we develop foundational technologies that enable this transformation. In this talk, I will focus on two key areas driving scalable quantum computing: autonomous system bring-up and algorithmic error suppression.

Autonomous system bring-up involves automating the calibration, tuning, and control processes that typically require manual oversight. These tools are critical to accelerating QPU foundry workflows and supporting stable operation in on-premises quantum deployments. By reducing the need for expert intervention, we enhance reproducibility, increase system uptime, and lower operational overhead—laying the groundwork for quantum hardware to become as manageable and dependable as its classical counterparts.

Alongside this, we present a high-performance hybrid quantum-classical solver designed for combinatorial optimization problems. Integrated with a comprehensive error suppression pipeline, this approach solves tasks such as Max-Cut, Maximum Independent Set, Max-SAT, and spin-glass ground state discovery, even when problem topologies do not align with hardware connectivity. In benchmarking studies, the solver consistently outperforms local classical heuristics—demonstrating strong performance under realistic constraints. Based on our results and the technology roadmaps of leading QPU manufacturers, we anticipate that quantum utility in these problem classes will be achievable by 2028.

The convergence of automation and algorithmic resilience is essential to realizing scalable, production-ready quantum computing. Together, these technologies provide the foundation for systems that are both operationally robust and capable of delivering meaningful performance on real-world workloads. This talk will outline how Q-CTRL's control and automation infrastructure is helping bridge the gap between current experimental platforms and a future of dependable quantum utility.