Real-time feedback at scale: From mid-circuit measurements to QEC

Dr. Florian Froning

Zurich Instruments AG, Technoparkstr. 1, 8005 Zurich, Switzerland

info@zhinst.com

To build a fault-tolerant quantum computer, we master the challenges of fidelity, scalability and quantum error correction (QEC). The quantum computing control system is a crucial part of this endeavour. It not only controls the quantum system but also provides the infrastructure for QEC and paves the path towards logical qubit operation. In this talk, we focus on the critical aspects in building control systems for quantum error correction: a scalable system architecture, hardware-software codesign, and reliability.

100-qubit scale QEC experiments are enabled by the scalable star-architecture of our Quantum Computing Control System (QCCS). The system controller, which has knowledge of the entire system state, features a programmable FPGA, where classical mid-circuit logic can be implemented. The feedback commands act on all connected signal generators with reliable latency and sample precision. Here, we show how mid-circuit measurements and real-time feedback are implemented in the QCCS.

These results show how the scalable system architecture of our control system is ideally suited for quantum error correction research aimed at developing logical qubits with algorithmically relevant error rates.

References

[1] Zurich Instruments, www.zhinst.com

Figures

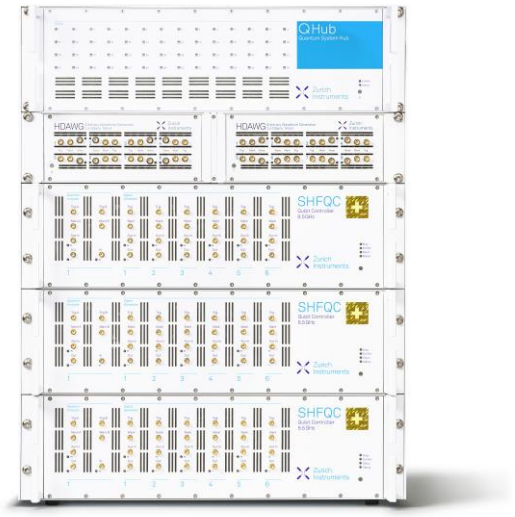

Figure 1: Zurich Instrument Quantum Computing Control System (QCCS). The central controller QHub enables the path from mid-circuit measurements to Quantum Error Correction.