river lane

HPC meets Fault Tolerant Quantum Computing

Headline first

What	Fault-tolerant quantum computation is becoming a reality. Quantum Utility in less than a decade.
Why now?	Opportunity: architect HPC and Quantum systems with shared energy goals. Start with software.
How?	Measure twice, cut once. Profile and measure what we can. Don’t wait for the final system.

Fault-tolerant quantum computation is becoming a reality.

- Every qubit type is making progress
- QPU vendors reaching sufficient error rate (99.9%) and qubit number to implement QEC

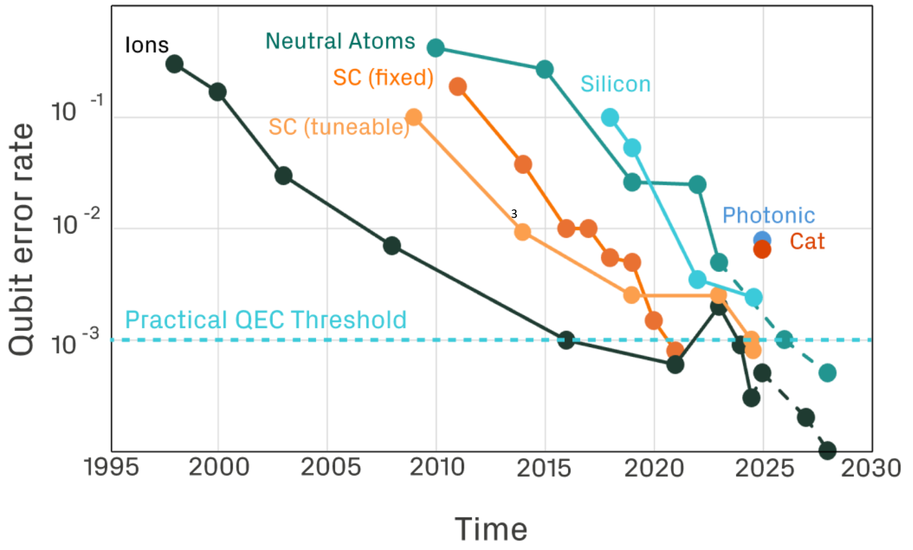


Figure 1: Qubit error rates for trapped ions (Ions), neutral atoms, superconducting (SC), silicon and photonic qubit technologies based on peer reviewed articles. The dashed lines show public roadmaps from companies developing the respective technology.

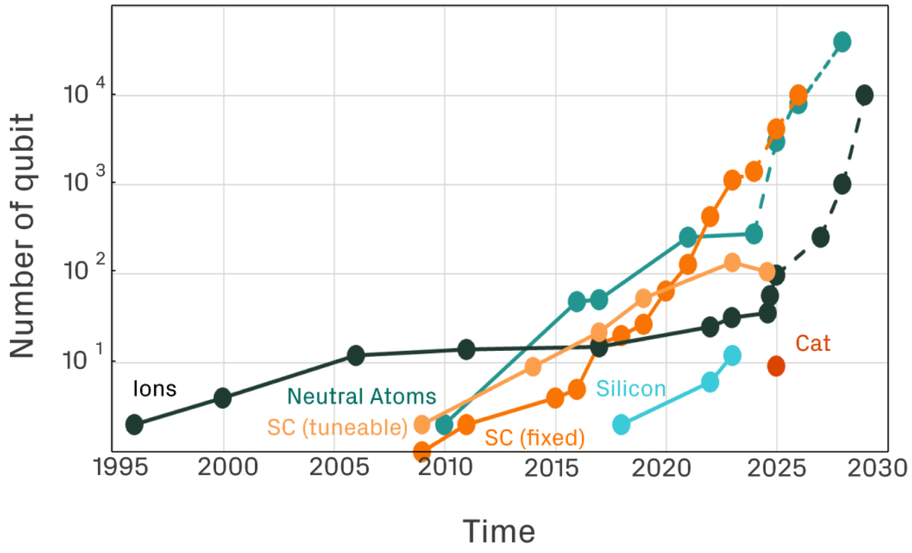


Figure 2: Number of physical qubits for trapped ions (Ions), neutral atoms, superconducting (SC), silicon and photonic qubit technologies based on peer reviewed articles. The dashed lines show public roadmaps from companies developing the respective technology.

Fault-tolerant quantum computation is becoming a reality.

High accuracy

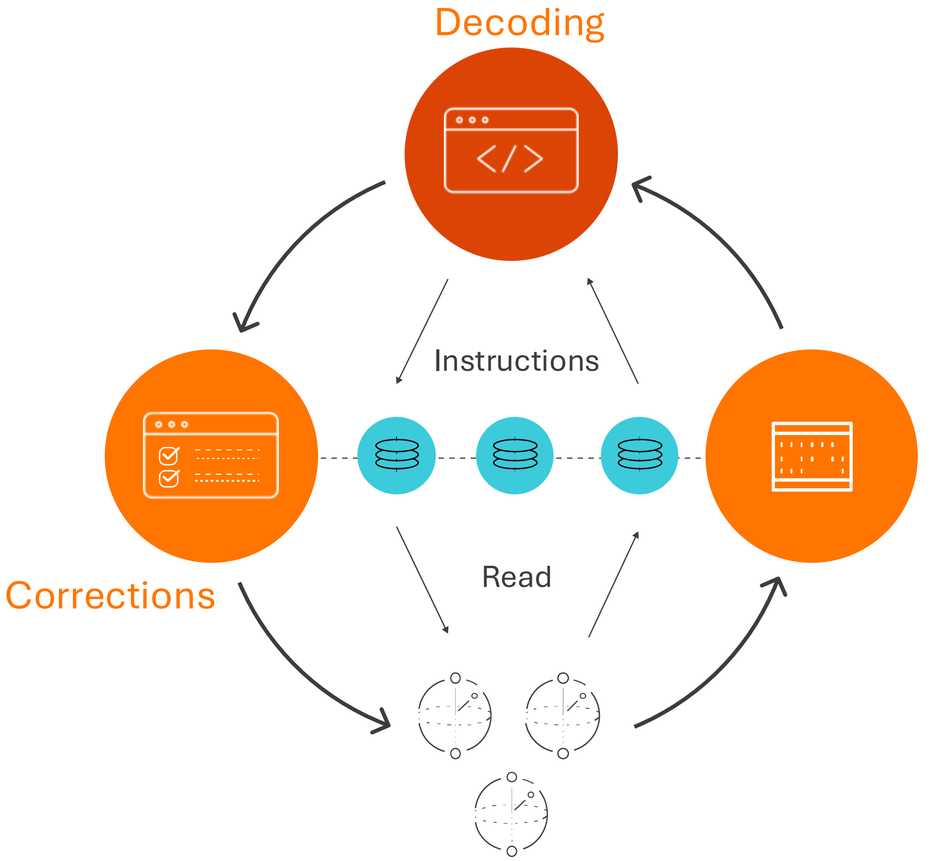
The decoding accuracy defines the number of error-free Quantum Operations (QuOps)

High throughput

The decoder must keep up with the error error generation rate of the quantum quantum processor - scaling to TB/s

Low latency

The QEC round has to be fast (<1μs)) and deterministic to avoid delays leading to uncorrectable errors.



Why software first?

Riverlane Decoder chip DD1 (superseded)

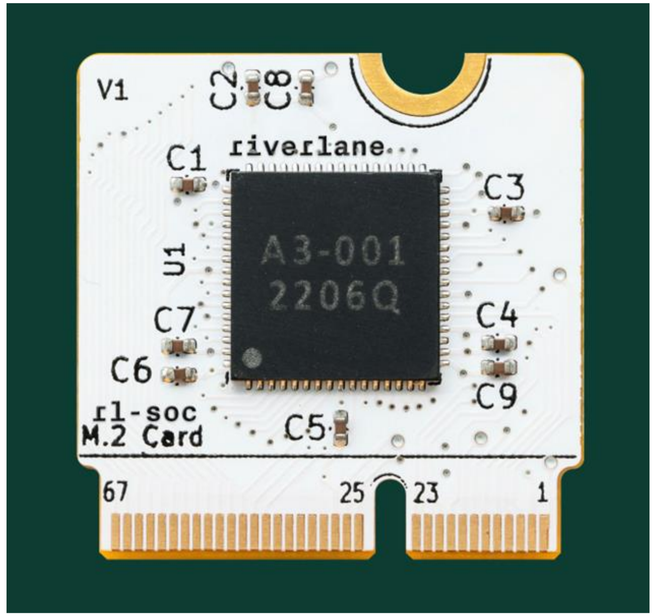
4.17 MHz decoding frequency

logical error rate of 10^{-12}

1W

0.78% threshold

Why software first?



Riverlane Decoder FPGA DD1 (superseded)

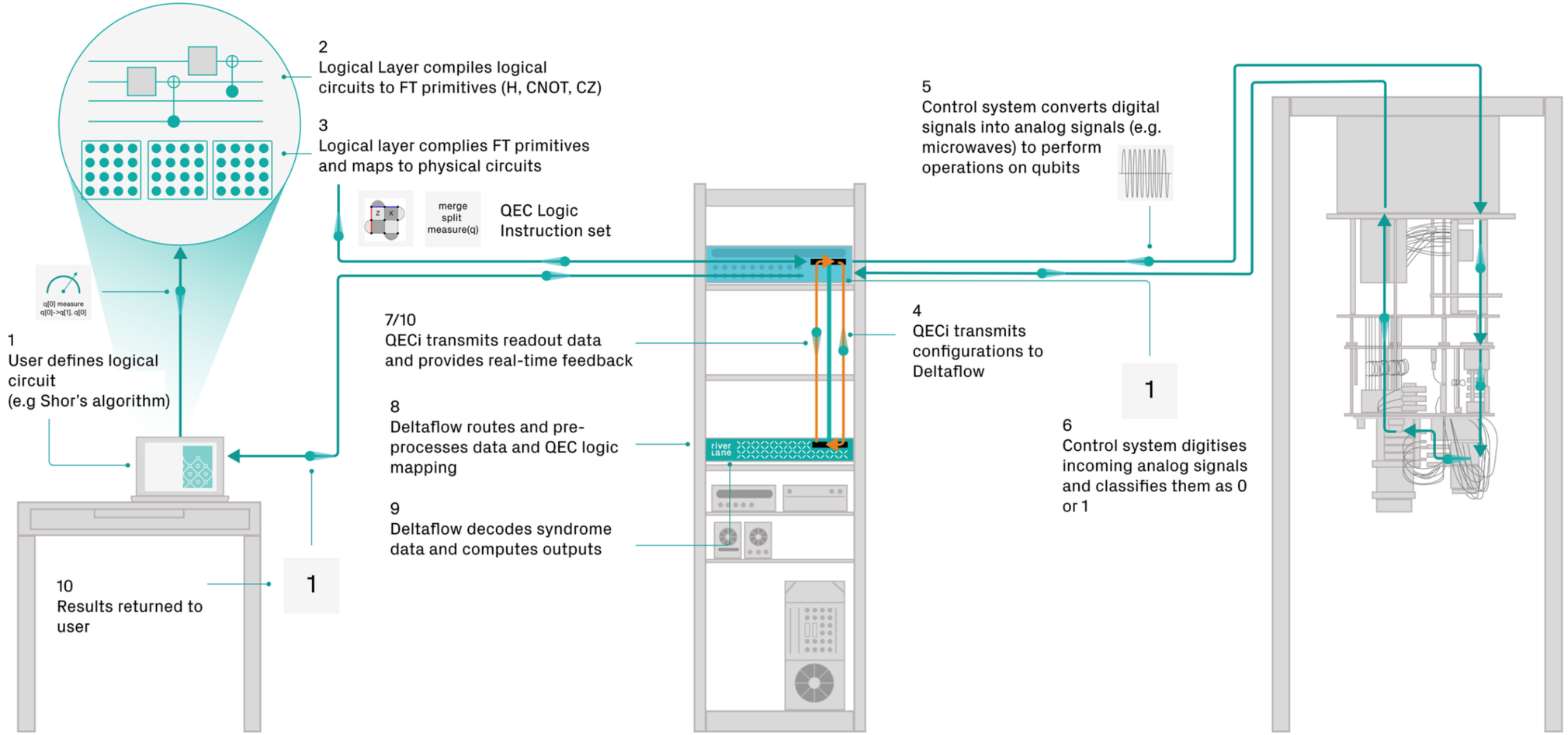
4.17 MHz decoding frequency

logical error rate of 10^{-12}

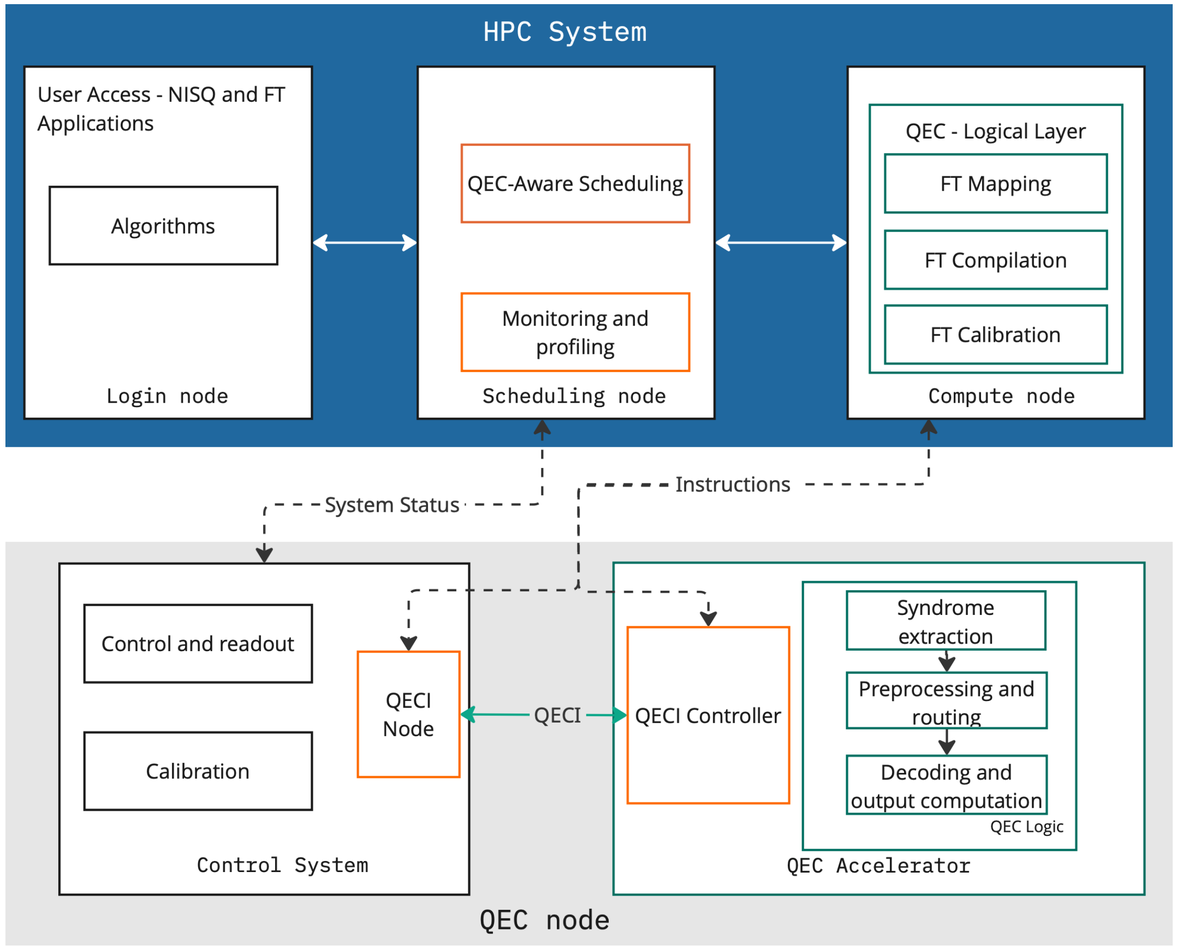
~50mW (20x reduction)

0.78% threshold

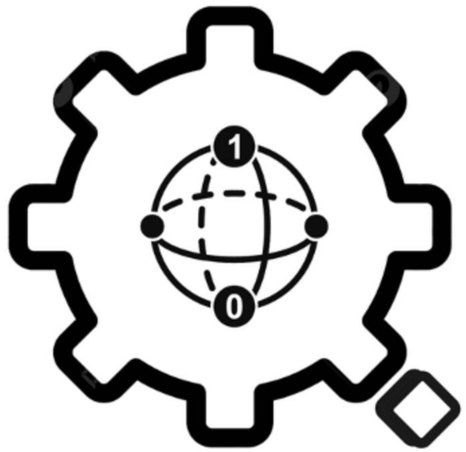
Measure twice, cut once. Single user view.



Measure twice, cut once. Here comes HPC.



Measure twice, cut once



Qstone (2024 - Summit+)

Instrument and generate synthetic benchmarks for multi-users, scheduler aware HPC+Quantum systems.

https://pypi.org/project/qstone/

Measure twice, cut once

Qimera (2025 – New Frontier)

Model a full HPCFTQC system in in terms of power and data movement.

Stay tuned.

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Thank you!

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