

QOLAB

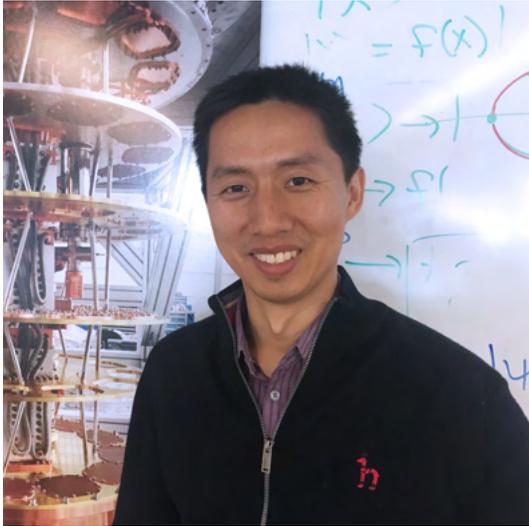
Collaborate Fabricate Scale



Qolab is a hardware company developing utility-scale superconducting quantum computers. We bring together deep physics and engineering expertise with semiconductor fabrication partnerships to solve the toughest challenges on the path to fault-tolerant scaling.

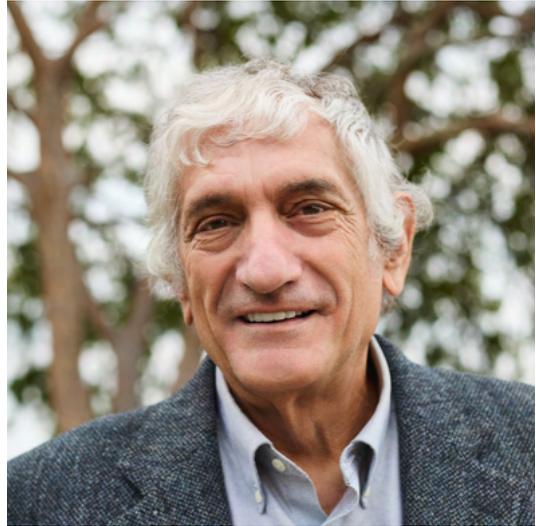
Leadership

Guided by pioneers of superconducting quantum computing, our team helps world-class semiconductor partners adapt their tools to improve qubit quality.



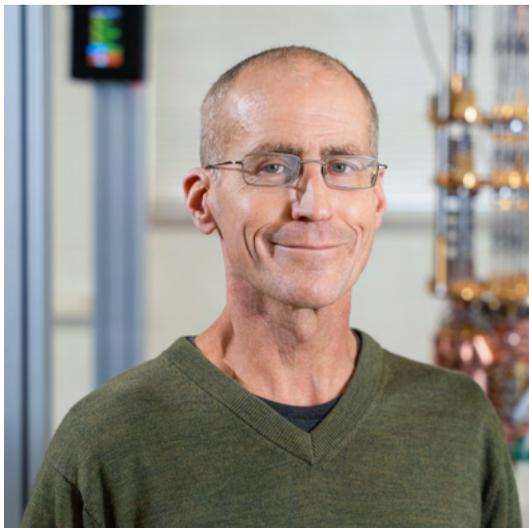
Alan Ho
CEO | Co-founder

Brings extensive experience as former Head of Product at Google Quantum AI, where he led product efforts behind the quantum supremacy experiment.



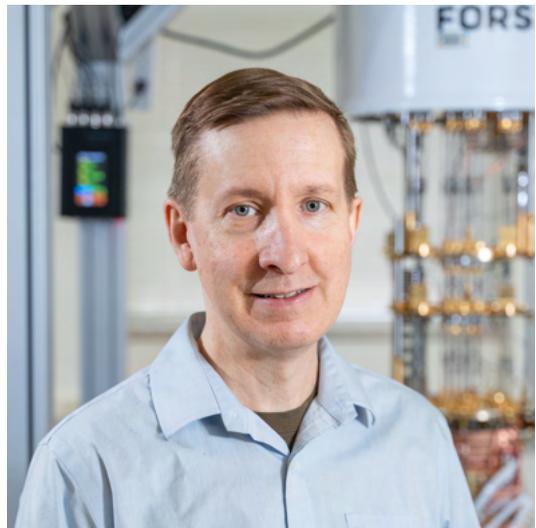
John Martinis
CTO | Co-founder

Distinguished physicist and 2025 Nobel laureate in Physics recognized for pioneering superconducting qubits and advancing scalable quantum systems.



Robert McDermott
Head of Hardware | Co-founder

UW-Madison professor and leading physicist advancing superconducting qubits, quantum measurement, and scalable quantum computing systems.

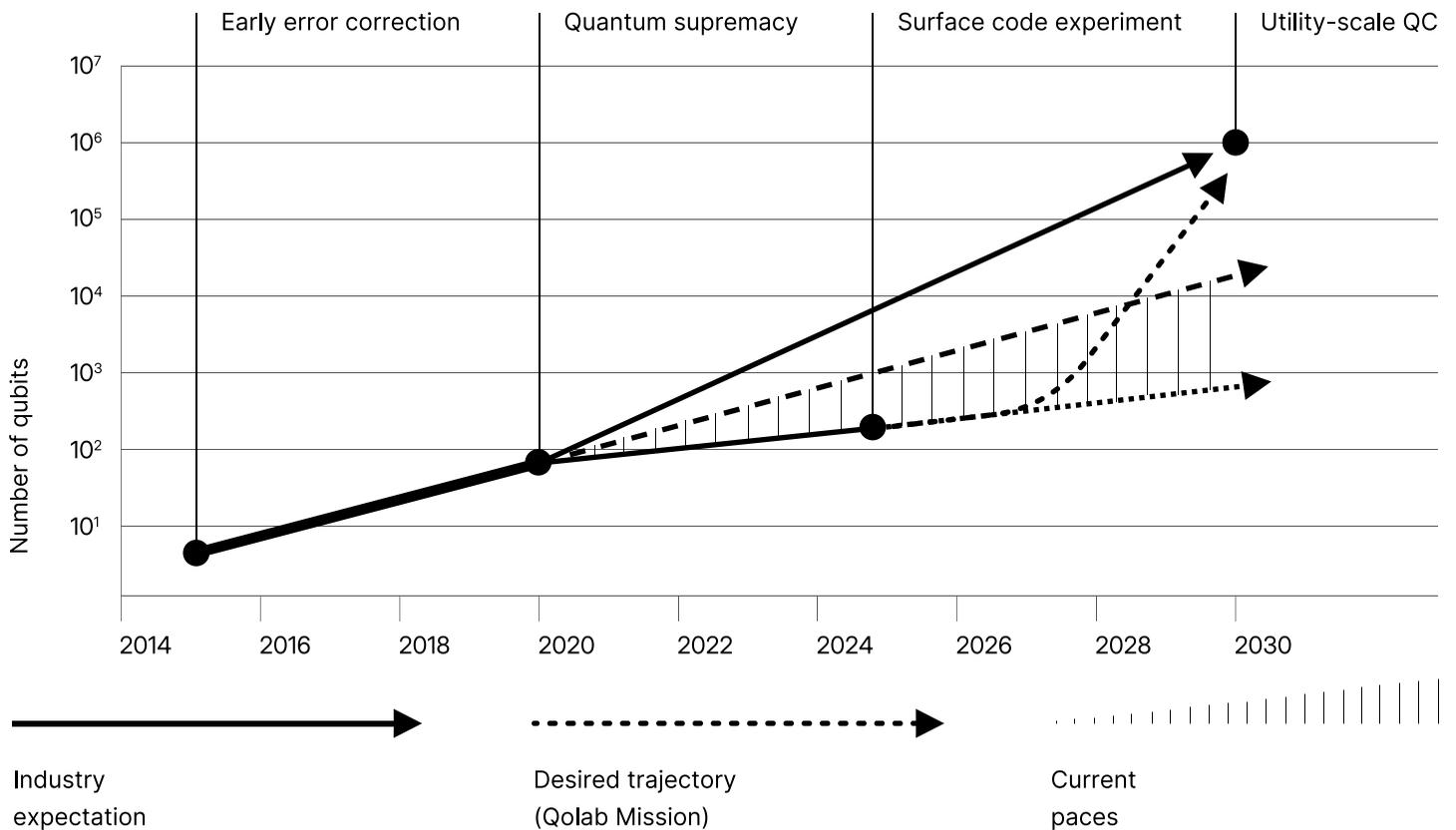


Britton Plourde
Quantum Hardware Engineer

Renowned physicist recognized for pioneering qubit readout and control techniques and designing efficient quantum circuits.

| The Scaling Problem

Despite major progress in quantum research, the industry's hardware trajectory remains far from the scale required for useful computation. The limitation isn't physics — it's scalability: the challenge of reproducibly fabricating qubits and integrating discrete components into manufacturable systems.



Scalability in quantum hardware depends on two tightly linked engineering challenges:

- | Yield optimization — achieving consistent, reproducible fabrication of high-quality qubits across full wafers.
- | Component integration — reducing reliance on discrete cryogenic components that prevent dense, modular system architectures.

Until these two problems are solved, quantum hardware will remain limited to experimental devices, far from the utility-scale systems needed for real-world computation.

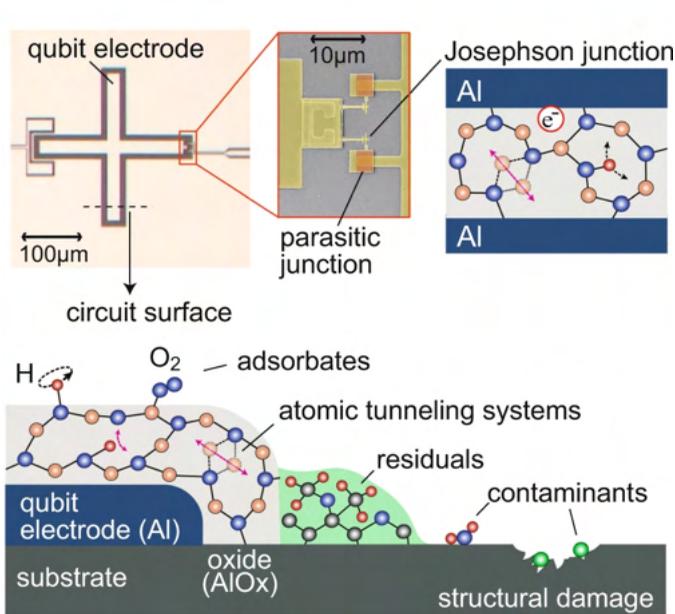
| The Yield Problem

Superconducting qubits remain limited by inconsistent fabrication quality. Even small variations in film thickness, junction uniformity, or material interfaces can cause significant fluctuations in coherence times and error rates. Today's fabrication technology based on lift-off is the main reason superconducting qubits are limited to 100-200 qubits per die.

While small-scale systems can rely on selecting the best-performing qubits, scaling to thousands or millions demands reproducible, high-yield processes – something traditional laboratory methods cannot provide.

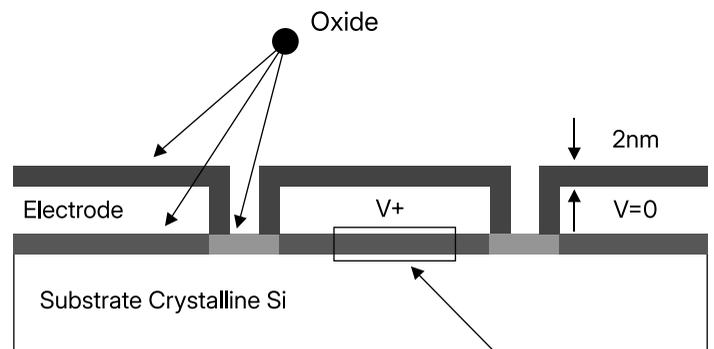
Cause: Decoherence from Imperfect Interfaces

At the root of the yield problem lies decoherence caused by atomic-scale imperfections. Amorphous or contaminated interfaces between metals and substrates host atomic-scale defects that act as two-level systems, absorbing energy and reducing qubit coherence. Conventional lift-off and deposition techniques introduce oxides and impurities that prevent industrial-grade uniformity across wafers.

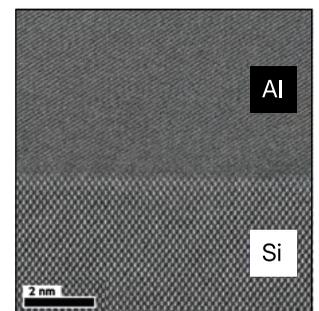


Amorphous insulators come from a variety of sources and locations

Source: J. Lisenfeld et al., "Electric field spectroscopy of material defects in transmon qubits", npj Quantum Information 5, 105 (2019).



Typical cross section showing 3 interfaces



AMAT in-situ clean showing atomically-sharp interface

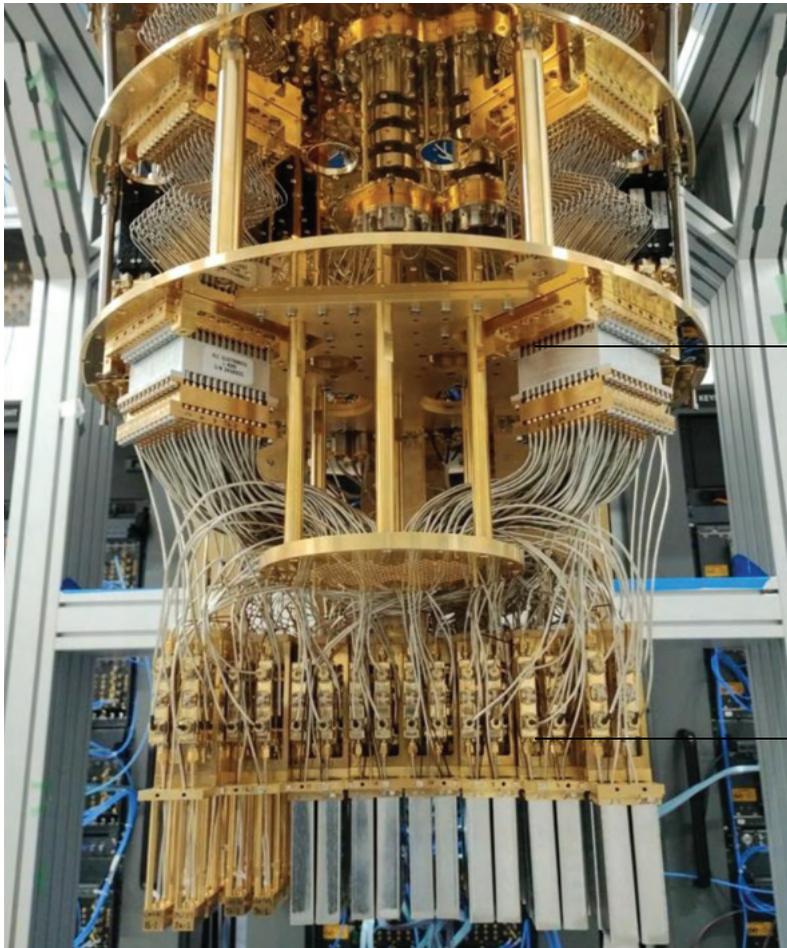
| The Component Integration Problem

Even with improved fabrication, most quantum systems today depend on discrete components — filters, attenuators, amplifiers, and wiring connecting each qubit to room-temperature electronics.

These bulky cryogenic parts take up valuable space, introduce heat, and ultimately limit the number of qubits per cryostat. This problem is known as CSWaP (Cost / Space / Weight / Power), and there is a fixed CSWaP budget available per cryostat. Scaling beyond a few thousand qubits per dilution refrigerator under this architecture becomes physically and economically infeasible.

Cause: Lack of Cryogenic Integrated Circuit

The CSWaP challenge existed for traditional electronics as well. It wasn't until the invention of the Integrated Circuit that all wires, transistors, and other components were miniaturized onto a single system. Today, if an NVIDIA Grace Blackwell chip were made with discrete components, it would take 600,000 km of wires, and over a \$1 trillion to operate due to power usage.

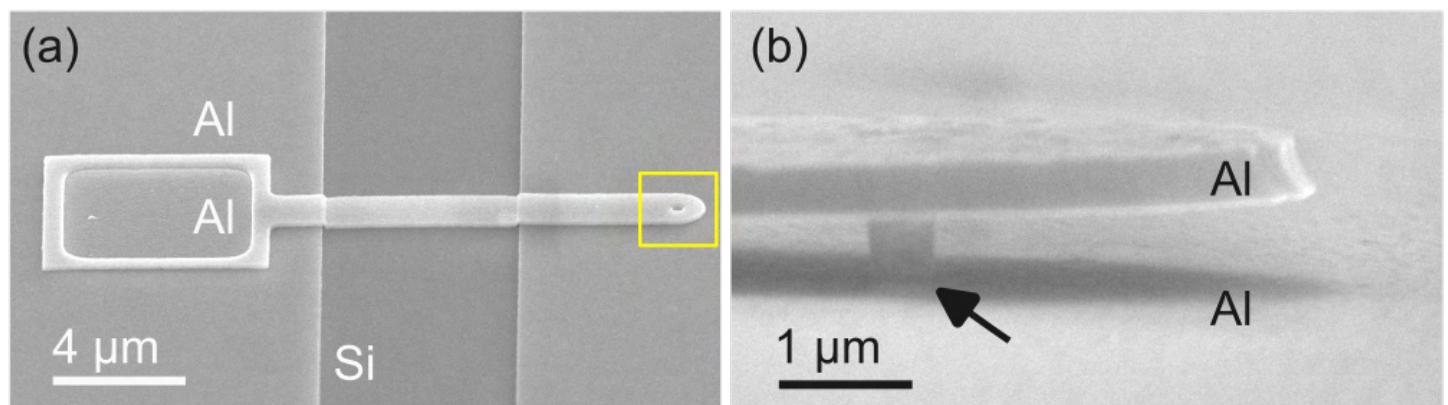
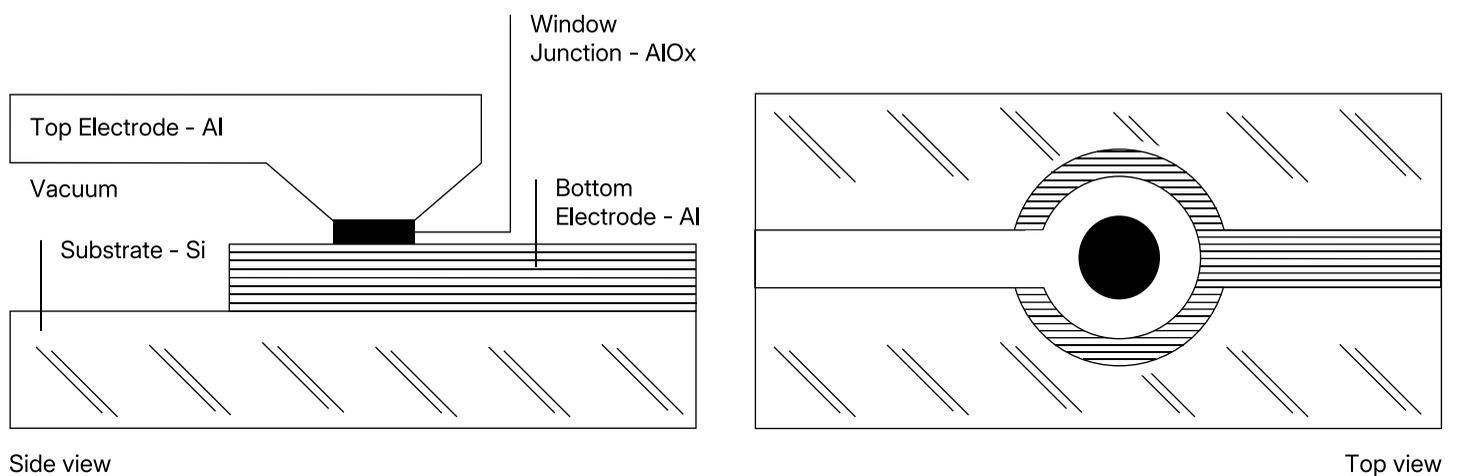


Fujitsu / Riken 256 qubit processor

Solution: Window-Junction Process

To overcome fabrication inconsistency, Qolab developed a window-junction process compatible with modern semiconductor fabrication techniques that replaces lift-off steps with subtractive etching. This eliminates contamination associated with lift-off processing, creating atomically clean and sharply defined interfaces.

The process scales naturally to 300 mm wafers, enabling reproducible, high-quality qubit performance across full wafers and laying the foundation for manufacturable quantum processors.



(a) Tilted-angle scanning electron microscope (SEM) image of the window junction (WJ).

(b) Magnified view of the junction structure, corresponding to the yellow square in (a); the arrow indicates the junction location.



Read Qolab's writepaper on Scaffold-Assisted Window Junction for Superconducting Qubit Fabrication

| Solution: Cryogenic Integrated Circuits

To overcome the physical limits of discrete components, Qolab is adapting Wafer-Scale Integration and Chip-on-Wafer-on-Substrate (CoWoS) techniques pioneered in the semiconductor industry for cryogenic components. The goal is to pack 100,000 qubits per dilution refrigerator - 100x more than what is capable using today's technology, and at a fraction of the cost.

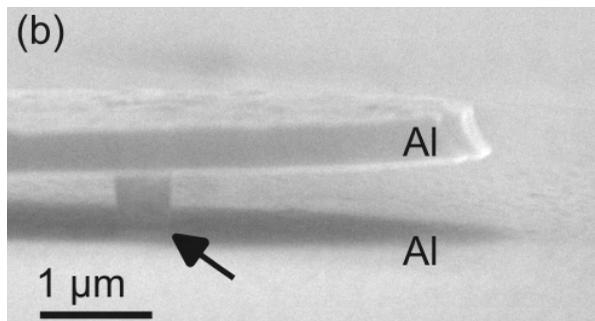
Each 140 mm x 140 mm qubit die hosts up to 20,000 qubits. The wiring wafer performs the following:

- | Integrates wiring from 3 K to 20 mK: eliminates most of the heat dissipation and cost associated with traditional coaxial wiring.
- | Integrates on-chip coplanar waveguide low-pass filters: eliminates bulky Eccosorb filters and microwave attenuators.
- | Integrates on-chip Josephson photomultiplier and SQUID amplifiers, eliminating bulky traveling-wave parametric amplifiers and microwave circulators.

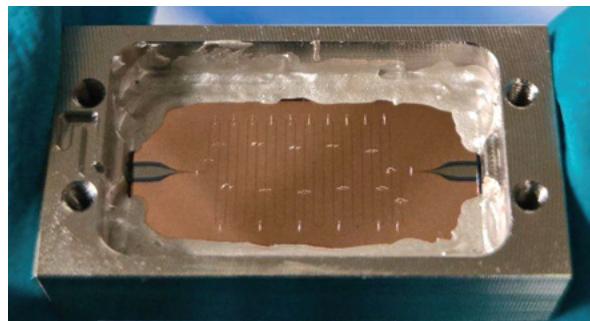


To learn more about the detailed technical roadmap toward scalable, fault-tolerant systems – including identified challenges in yield, integration, and system design – read our position paper “How to Build a Quantum Supercomputer.”

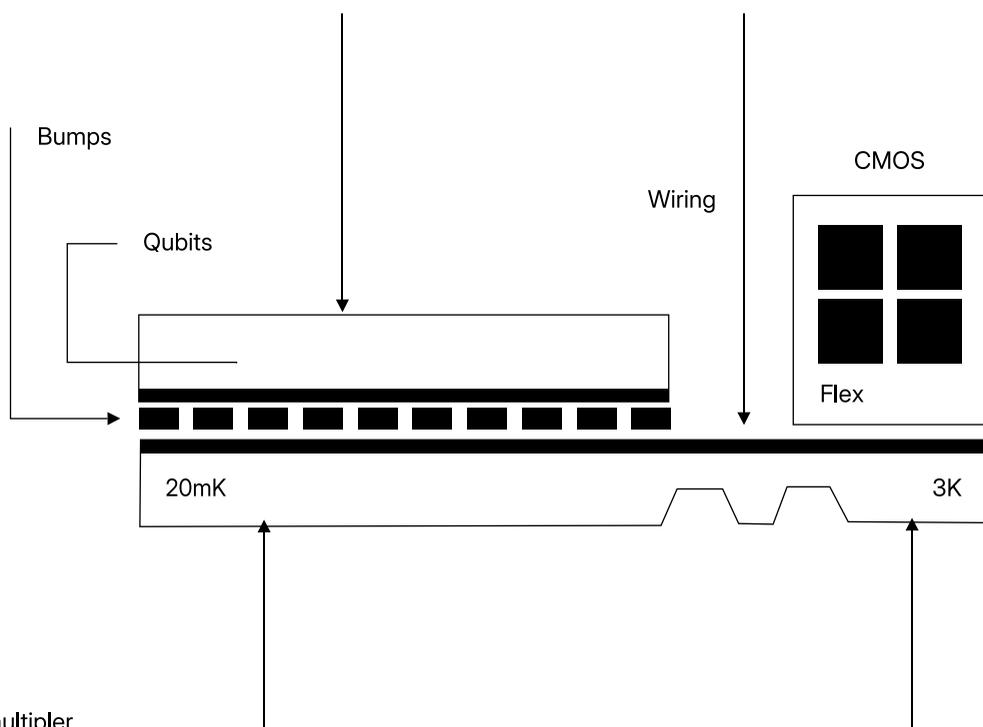
The qubit wafer and wiring wafer are bonded to create a single tiling module. Modules are tiled through capacitive coupling, creating compact, modular systems with dramatically lower cost and higher thermal efficiency.



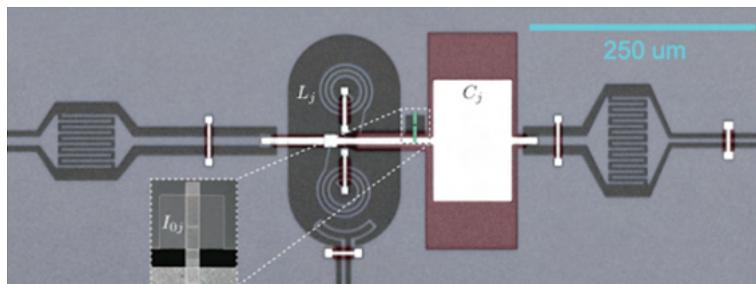
Window junction



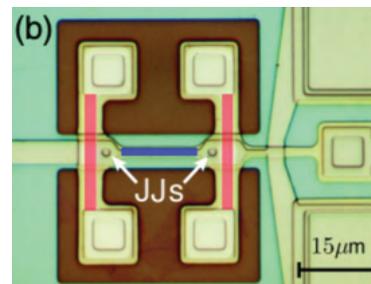
CPW filter



Josephson photomultiplier



SQUID amplifier



| Solution: Semiconductor Ecosystem Collaboration

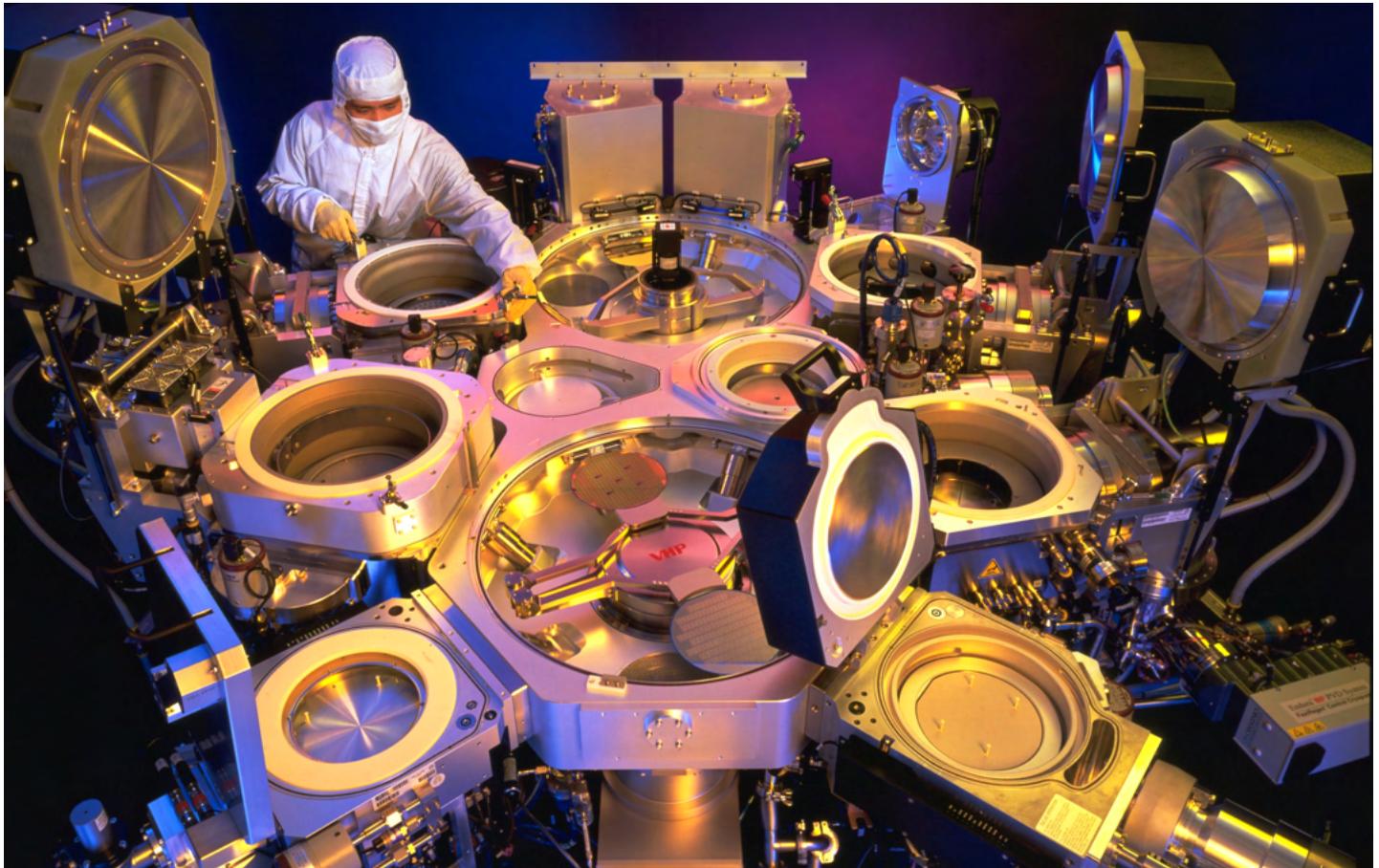
“Qolab” stands for Quantum Collaboration – our guiding principle in building scalable quantum systems through partnership. By partnering with global semiconductor leaders, Qolab adapts advanced manufacturing technologies to produce superconducting qubits and cryogenic components, enabling better qubits, mass manufacturing, and lower costs.

Fabrication - Applied Materials

Applied Materials is a global leader in materials engineering, with decades of experience creating atomic-scale fabrication tools used in nearly every advanced semiconductor device. Their expertise in 300 mm wafer processing makes them an ideal partner for advancing superconducting qubit technology.

In 2023, the partnership delivered a major milestone: using advanced processing, Qolab demonstrated the use of modern semiconductor tools to fabricate window junctions. This success led Applied Materials to retrofit its facilities specifically for qubit manufacturing in collaboration with Qolab—establishing a new standard for industrial-grade quantum fabrication.

AMAT cluster tool





Quantum Machines provides advanced quantum control systems and orchestration software used to operate Qolab's superconducting qubits. Their Quantum Orchestration Platform enables precise, low-latency control across large qubit arrays, ensuring optimal performance, reliability, and scalability.

Control Systems



Synopsys, a global leader in electronic design automation (EDA), is working with Qolab to develop specialized EDA workflows for quantum hardware. These tools manage the complex design processes behind superconducting qubits and circuits, enhancing Qolab's ability to streamline development, reduce crosstalk, and accelerate system scalability.

EDA tools



**Hewlett Packard
Enterprise**

Hewlett Packard Enterprise partners with Qolab to integrate quantum systems with classical supercomputing infrastructure. Leveraging HPE's experience in high-performance computing, this collaboration enables hybrid architectures capable of tackling complex computational challenges with greater efficiency.

Supercomputing Infrastructure

QOLAB

qolab.ai
contact@qolab.ai