Quantinuum:

Building Quantum Applications for Drug Discovery

Hardware, software, and algorithm development for life sciences

Tanya Roussy & Mario Gattuso | Quantinuum

AI-Driven Drug Discovery Summit | October 27, 2026



Rendering of a deployed Quantinuum Helios syster

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Why quantum computing alongside classical HPC and AI?

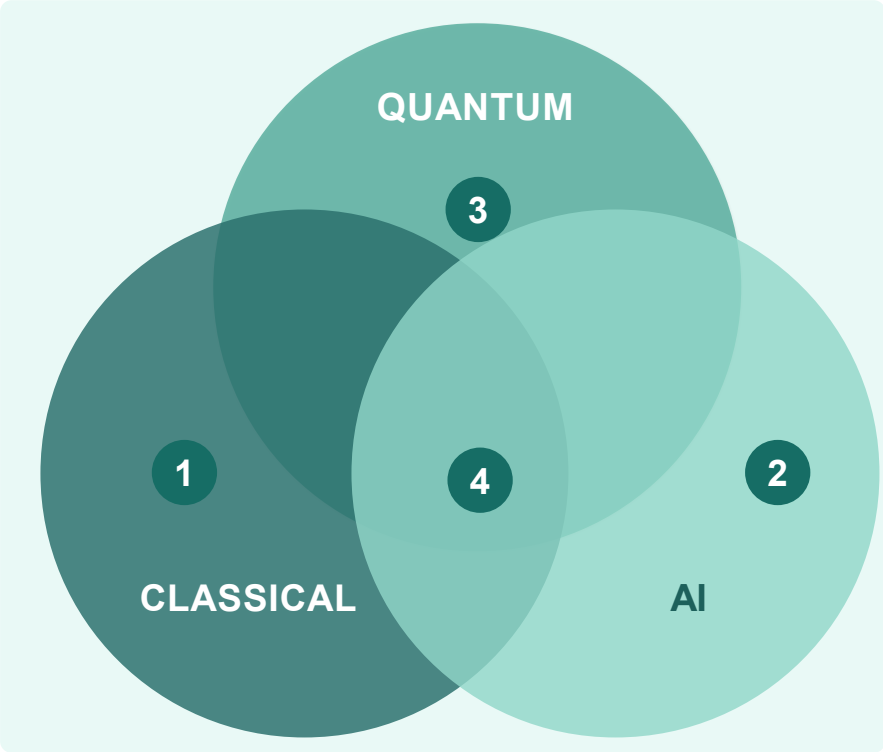
CLASSICAL AND AI DRIVE DISCOVERY. QUANTUM MAY HELP WITH DIFFICULT CALCULATIONS.

1 CLASSICAL COMPUTING TODAY

Molecular dynamics, electronic-structure methods, and HPC model molecules, mechanisms, and properties.

2 AI IN DRUG DISCOVERY

AI accelerates screening, property prediction, and molecular design, but depends on data quality and generalization.



3 WHERE QUANTUM MAY HELP

Quantum algorithms may help with difficult electronic-structure calculations when classical cost or accuracy becomes limiting.

4 BRINGING METHODS TOGETHER

Benchmark quantum and hybrid methods against established AI and HPC approaches to test their scientific value.

Research goal: benchmark against strong classical baselines before claiming advantage.

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Quantinuum combines quantum hardware, software, and algorithm development

Three complementary capabilities

Full-stack platform

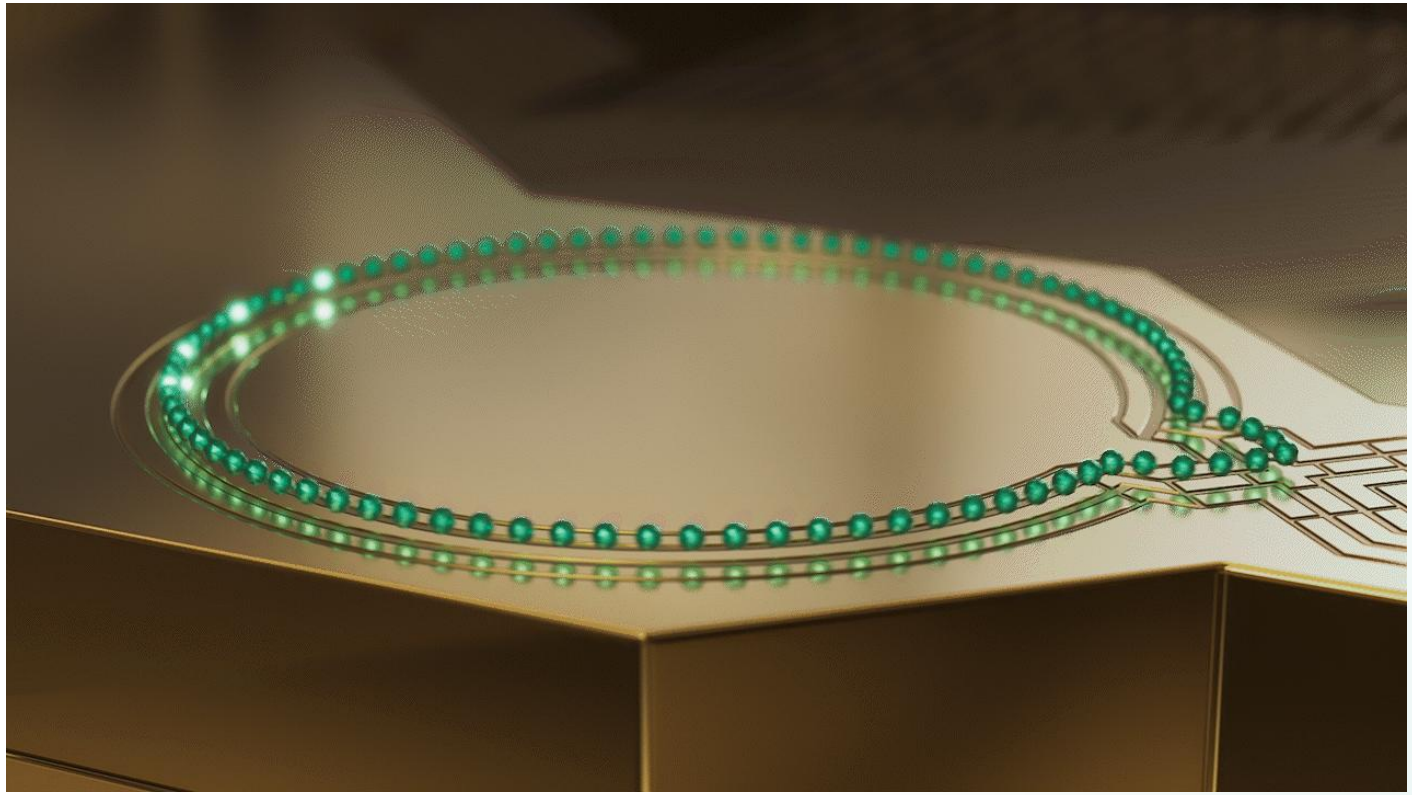
Integrated quantum hardware, developer software, and tools for algorithm development and execution.

Scientific and algorithm expertise

Teams developing quantum chemistry, computational biology, quantum machine learning, and hybrid quantum-classical methods.

Hardware built to scale

High-fidelity trapped-ion systems, demonstrated quantum error correction, and a fault-tolerant roadmap.



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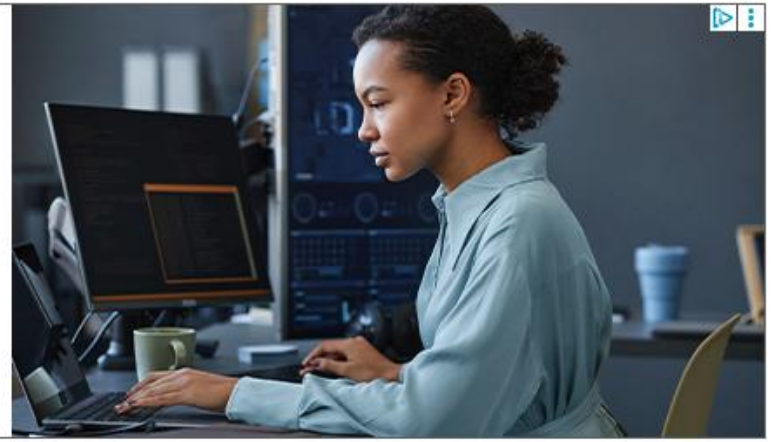

EXCLUSIVE TECHNOLOGY

Quantinuum Sees Path to Fault-Tolerant Quantum Computing by 2029 With New Milestone

Company says it has achieved a record-setting result on a problem that has bedeviled the industry for years

By Elias Schisgall
Oct. 19, 2026 6:51 am ET

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From quantum algorithms to applications: Quantinuum's full-stack platform

Quantum development tools
Guppy, APIs, SDKs, open-source tools

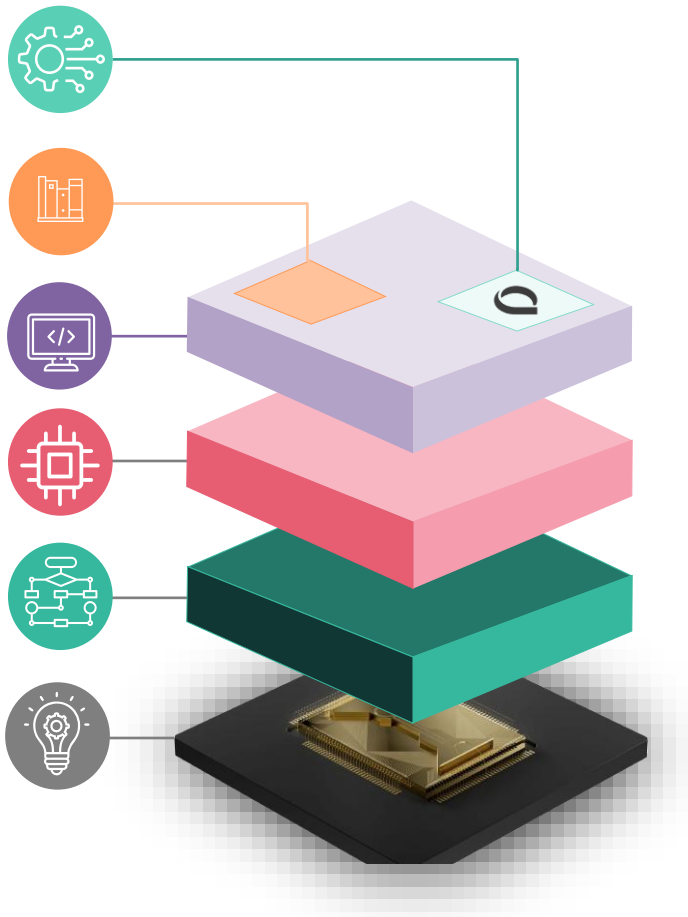
Scientific algorithms and applications
Quantum chemistry & machine learning

Nexus
Cloud platform for hybrid quantum-classical workflows

Compiler

Runtime Software

Quantum processing unit



Quantinuum's full-stack supports...

- High-fidelity hardware
- \+
- Hybrid computation
- \+
- Application development
- =
- Scientific Research
- Application Development

Note: [1] Based on our Helios system's two-qubit gate fidelity of 99.921% as of December 31, 2025, which is the highest two-qubit gate fidelity among commercially available gate-based quantum computing systems, based on the 2025 Montañez-Barrera et al. Study and our analysis of public filings of our peer companies

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Our Roadmap to
Universal, Fault-Tolerant Quantum Computing

	2020	2023	2025	2027	2029	2030+
SYSTEMS	SYSTEM MODEL H1	SYSTEM MODEL H2	QUANTINUUM HELIOS	QUANTINUUM SOL	QUANTINUUM APOLLO	QUANTINUUM LUMOS
PHYSICAL QUBITS	20	56	98	192	1,000s	1,000,000+ QUBITS
PHYSICAL 2-QUBIT GATE ERROR	1×10^{-3}	1×10^{-3}	$< 5 \times 10^{-4}$	$< 2 \times 10^{-4}$	1×10^{-4}	
LOGICAL QUBITS		> 12	48	~ 100	100s	
LOGICAL ERROR RATES		1×10^{-3}	$< 10^{-4}$	$\sim 10^{-5}$	1×10^{-5} to $1 \times 10^{-10*}$	

*analysis based on recent literature in new, novel error correcting codes predict that error could be as low as 1E-10 in Apollo (ref: arXiv:2403.16054, arXiv:2308.07915).

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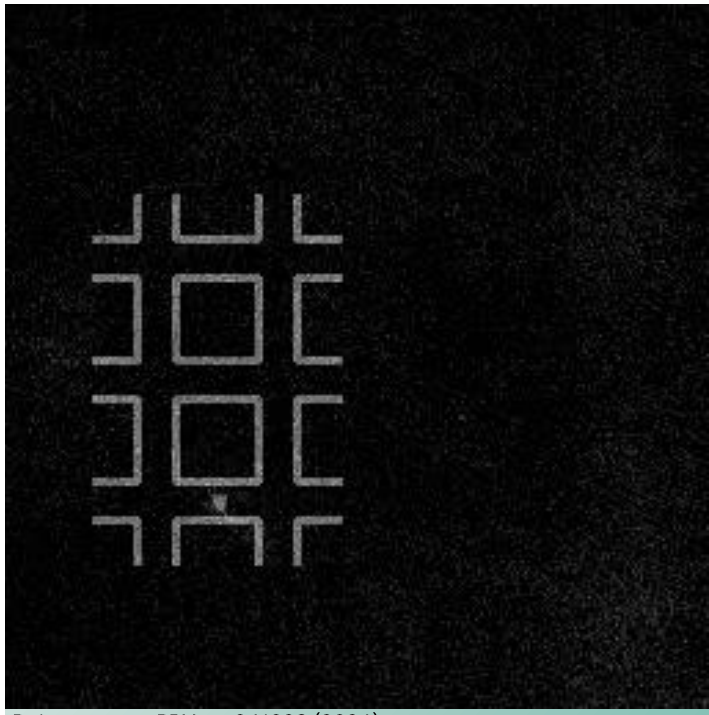
2D junction transport in a Quantinuum QCCD ion trap



Delaney, *et al.*, PRX ***14***, 041028 (2024)
Burton, *et al.*, PRL ***130***, 173202 (2023)
Malinowski, Allcock, and Ballance, PRX Quantum ***4***, 040313 (2023)
Kielpinski, Monroe, and Wineland, Nature ***417***, 709-711 (2002)

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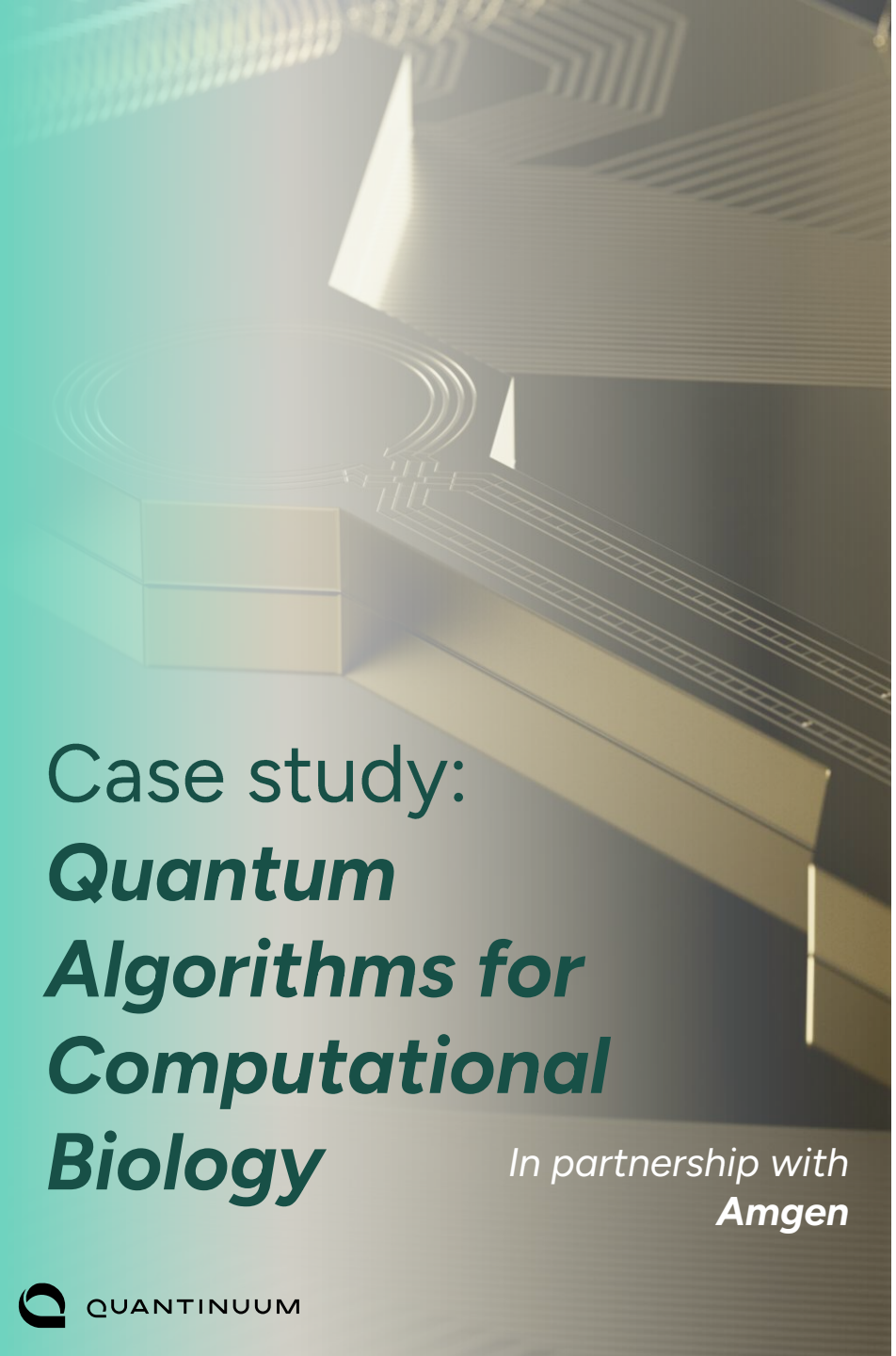

Case study: *Quantum Algorithms for Computational Biology*

In partnership with ***Amgen***

The peptide binding problem

Peptide–MHC binding helps determine immune recognition and is relevant to vaccine and immunotherapy research.

Quantum machine learning approach

Quantinuum and Amgen explored a compositional quantum natural language modelling for peptide classification, with an emphasis on interpretability.

Demonstrated on quantum hardware

A peptide-classification proof of concept was executed on Quantinuum hardware, establishing technical feasibility. Further benchmarking is needed to assess performance relative to classical methods.

Algorithm development for computational biology

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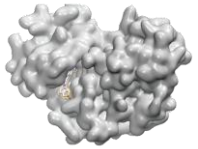
Quantum + AI Chemistry: From Technical Demonstration to Pharma Research

Why Drug Stability Matters



Drug degradation and stability affect shelf life, safety, and development decisions.

Potential Quantum Contribution



Quantum-derived chemistry information may improve selected difficult molecular calculations.

Research Collaboration

Pfizer & NVIDIA &

Provides chemistry context and test problems

Contributes CUDA-Q and GPUs

Develops GenQAI and quantum hardware

H2 → HELIOS → SOL → APOLLO → LUMOS

Demonstrated on Hardware

Phase 1: Demonstrated on hardware

Hybrid quantum chemistry circuits executed on Helios using 12-16 qubit active spaces.

Advancing the Algorithms

Phase 2: AI-assisted Algorithm Development

In the reported comparison, GenQAI methods reduced circuit-generation time by 3–4 orders of magnitude versus ADAPT-VQE.

Pharma Research Goals

Phase 3: Pharma Research Goal

Extend the methods to more complex molecular chemistry and evaluate their potential for drug stability, degradation, and reaction predictions.

Evidence

Hardware feasibility demonstrated.

Pharma benefit still to be tested.

Source: Internal technical review (2026).

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Developing quantum applications for pharmaceutical R&D

Quantum computing can complement AI and classical methods on selected scientific problems. Algorithm development and benchmarking are already underway.

01 Develop and benchmark today

Hybrid workflows

Develop quantum algorithms alongside established AI, modeling, and HPC methods.

Benchmark on real systems

Evaluate accuracy, runtime, cost, and scale against strong classical baselines.

02 Target pharmaceutical problems

Complex molecular chemistry

Explore stability, degradation, reaction pathways, and other difficult chemical calculations.

Biological mechanisms

Investigate selected metabolism, enzyme, and complex electronic-structure problems.

03 Expand with advancing hardware

Larger molecular systems

Extend validated algorithms toward richer models and more complex mechanisms.

Fault-tolerant capabilities

Develop methods for increasingly complex molecular simulations as fault-tolerant hardware matures.

Our approach: Identify a meaningful scientific problem, develop and benchmark the right algorithms, and evaluate where quantum can provide differentiated value.

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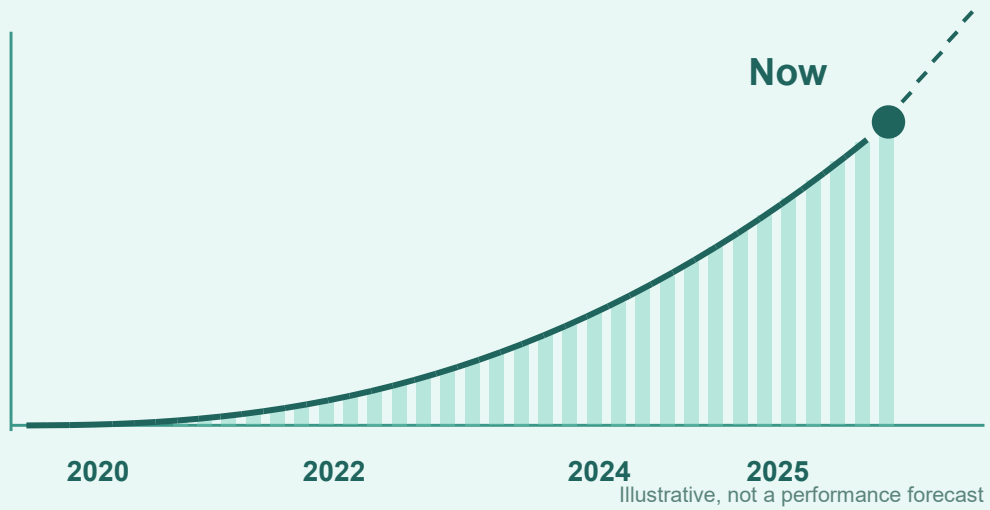
WHY START NOW?

Build the foundation for quantum applications



Engage now to develop algorithms, expertise, and evidence for future quantum applications.

Define scientific opportunities

Identify computational bottlenecks, relevant molecules, and limitations of established modeling methods.

Develop and benchmark algorithms

Build quantum methods, establish strong classical baselines, and test feasibility on available hardware.

Build capability as hardware advances

Develop expertise, reusable methods, and collaborations that can grow with more capable quantum systems.

Conceptual illustration of algorithm and capability development. No quantum advantage implied.

Public

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How life-sciences organizations can work with Quantinuum

01 Explore scientific problems

Start with the scientific decision



Identify an important scientific decision and where established computational methods fall short.

Agree on the problem owner, representative data, and current classical approach.

02 Develop and benchmark algorithms

Define baseline	Review established AI and HPC methods.
Develop methods	Select suitable quantum methods.
Test feasibility	Compare accuracy, cost, and runtime.
Measure value	Test impact on the scientific decision.

03 Build toward future capability

- **Build reusable algorithms and workflows**
- **Develop scientific and quantum expertise**
- **Expand to larger or harder molecular problems**
- **Advance collaboration as evidence and hardware improve**

Start with a scientific problem. Develop and benchmark algorithms. Build toward meaningful applications.

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Three takeaways

A CLEAR PATH TO BEGIN, LEARN, AND SCALE WITH QUANTINUUM

1

Quantum complements AI and HPC

Quantum algorithms may complement classical simulation and AI on selected difficult molecular calculations.

2

Hardware and algorithms advance

Quantinuum combines high-fidelity systems, developer tools, and algorithm research to test new methods.

3

Evidence guides scientific value

Evaluate accuracy, computing cost, and decision impact before pursuing larger pharmaceutical problems.

How to Engage

A CLEAR PATH TO BEGIN, LEARN, AND SCALE WITH QUANTINUUM

1

START: Define the scientific problem

Identify a scientific owner, representative inputs, and the strongest classical baseline.

2

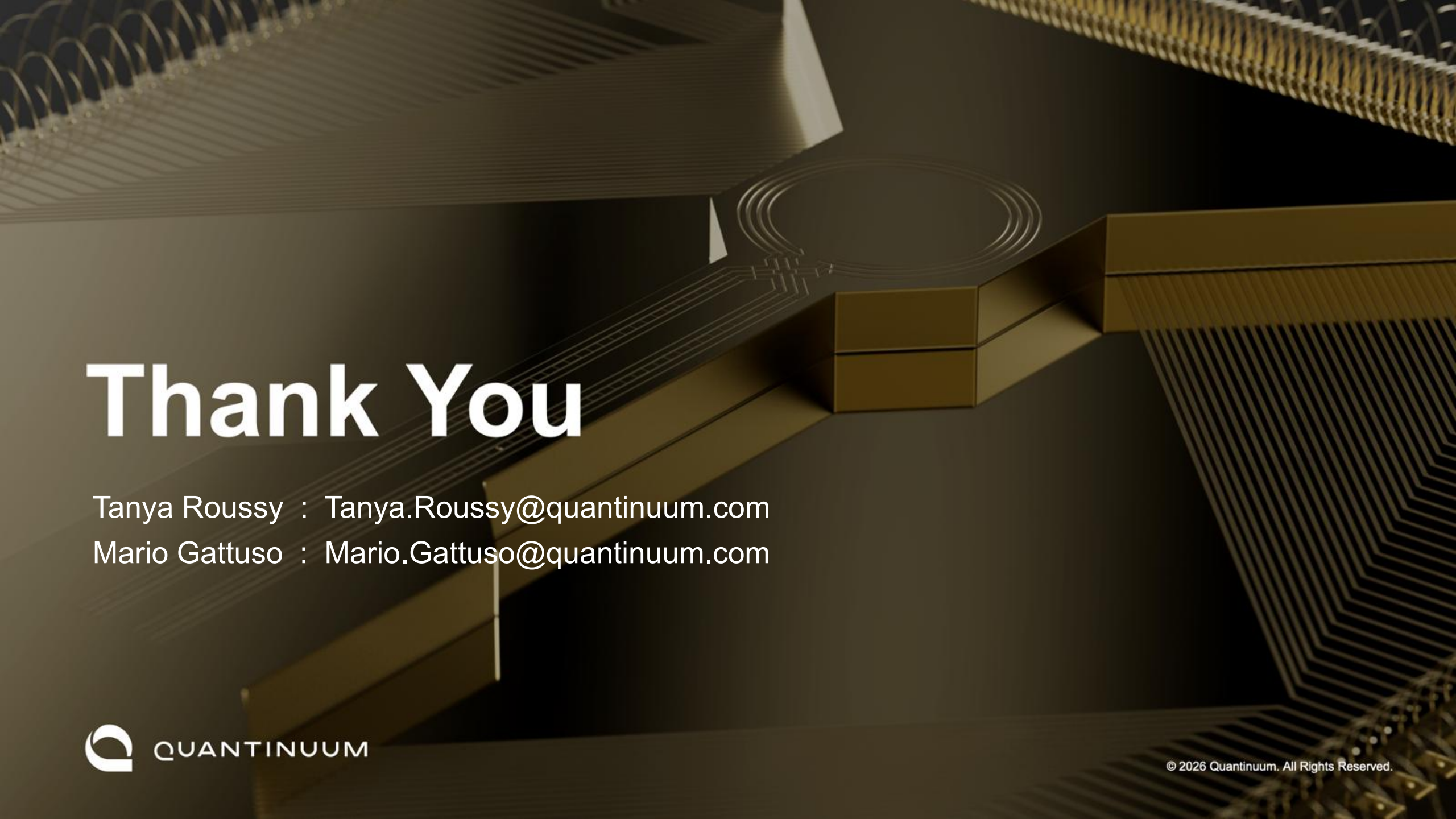
GROW: Develop and benchmark

Test algorithms with Quantinuum and application partners, including Kvantify where relevant.

3

SCALE: Expand where evidence supports it

Build reusable expertise and workflows as technical results and hardware capability improve.



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Trapped Ion Quantum Computing



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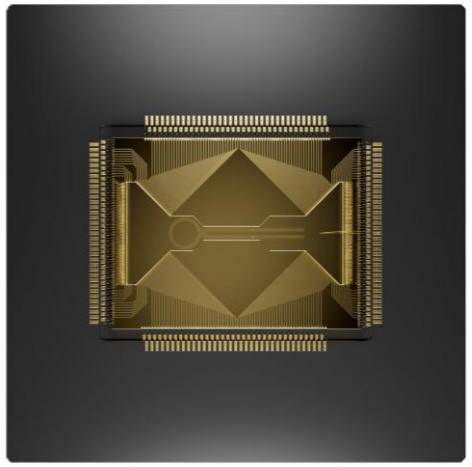
Microfabricated chips



- Ions levitated above a microfabricated chip

- Electromagnetic fields move and hold ions

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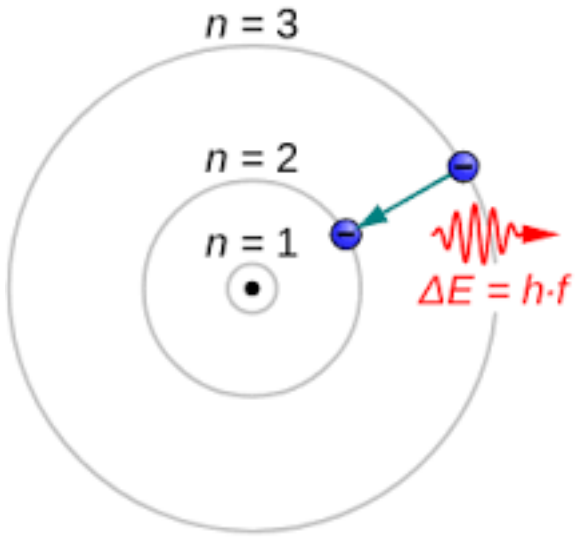
Ion Qubits



- Use Hyperfine structure to manipulate qubits
- All optical control of states

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Quantinuum Helios

*The world's most accurate quantum computer**

98 fully-connected physical qubits

99.9975%
Single-qubit gate fidelity

99.921%
two-qubit gate fidelity across all qubit pairs

99.95%
state preparation and measurement fidelity

*based on Helios' 99.921% average two-qubit gate fidelity, as of December 31, 2025, the highest two-qubit gate fidelity among commercially available gate-based quantum computing systems [2025 Ransford et. al.]



Image: Visual representation of Helios deployed at a customer site

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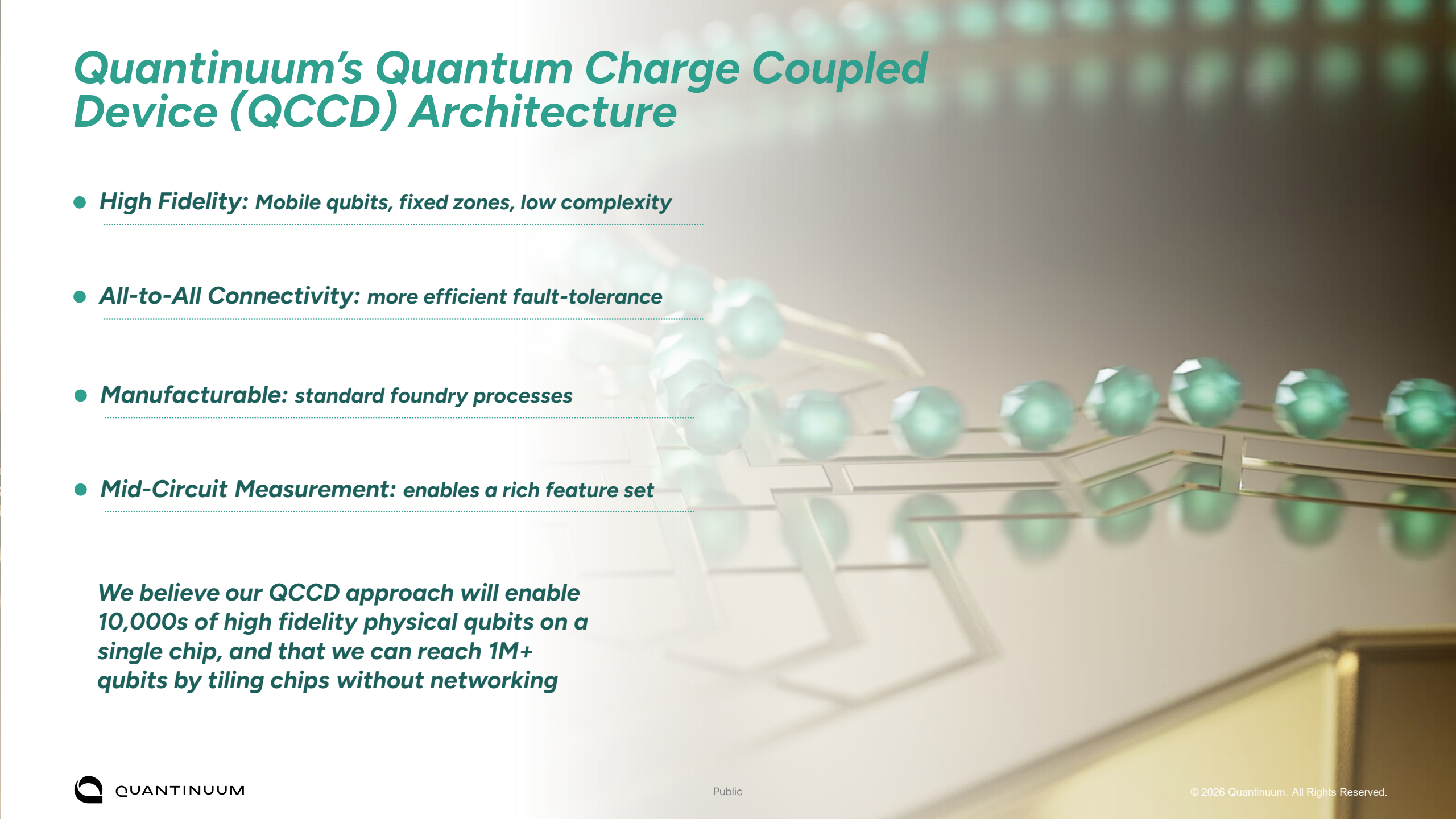
Quantinuum's Quantum Charge Coupled Device (QCCD) Architecture

- ***High Fidelity:*** *Mobile qubits, fixed zones, low complexity*
- ***All-to-All Connectivity:*** *more efficient fault-tolerance*
- ***Manufacturable:*** *standard foundry processes*
- ***Mid-Circuit Measurement:*** *enables a rich feature set*

We believe our QCCD approach will enable 10,000s of high fidelity physical qubits on a single chip, and that we can reach 1M+ qubits by tiling chips without networking



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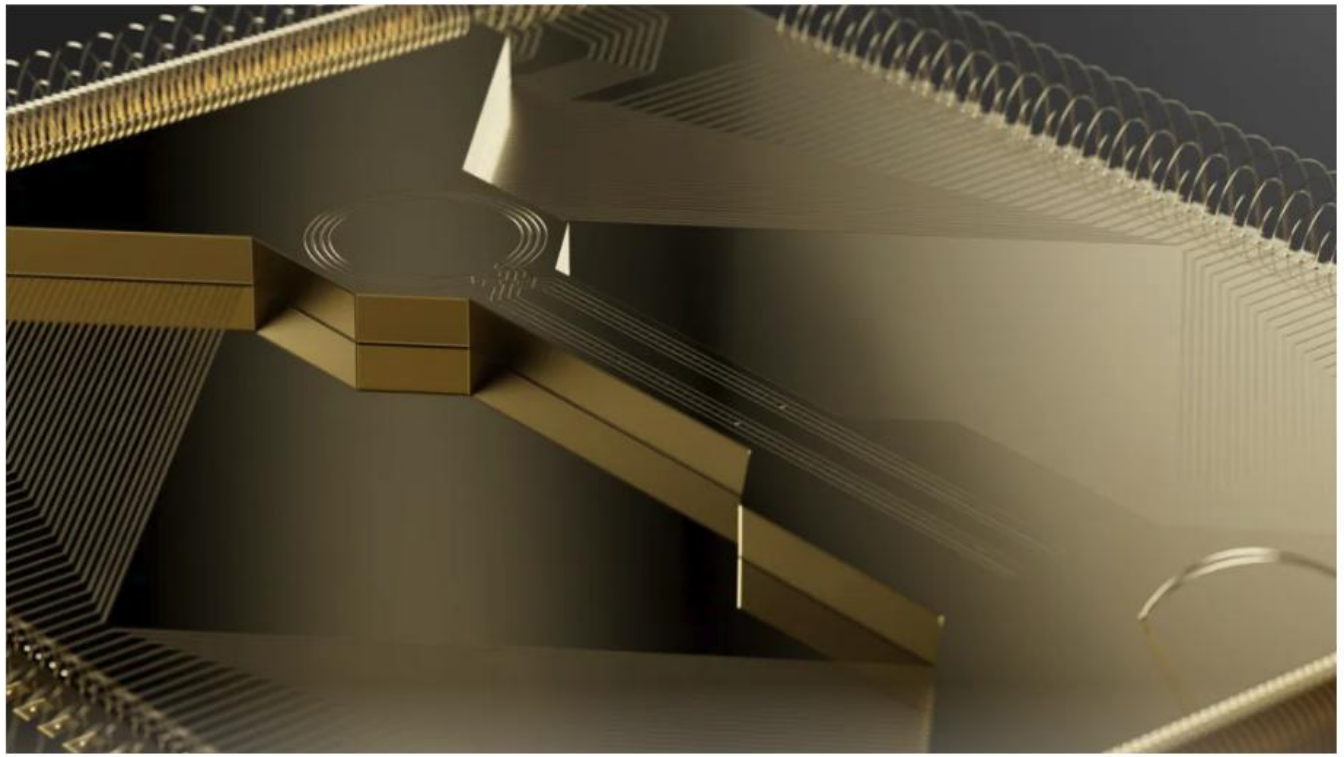
NEWS PHYSICS

A quantum computing feat brings the ‘megaquops’ era a step closer

Error correction creates qubits that glitch only 5 out of a million times



A quantum chip made by Quantinuum (shown) demonstrated a qubit that made errors only five times out of a million.

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