# The Era of Quantum Utility IBM **Quantum**

Zora Hollá IBM Quantum Ambassador



## Quantum state of play

Since we put the first quantum computer on the cloud in 2016, quantum computing has largely been in an exploratory phase.

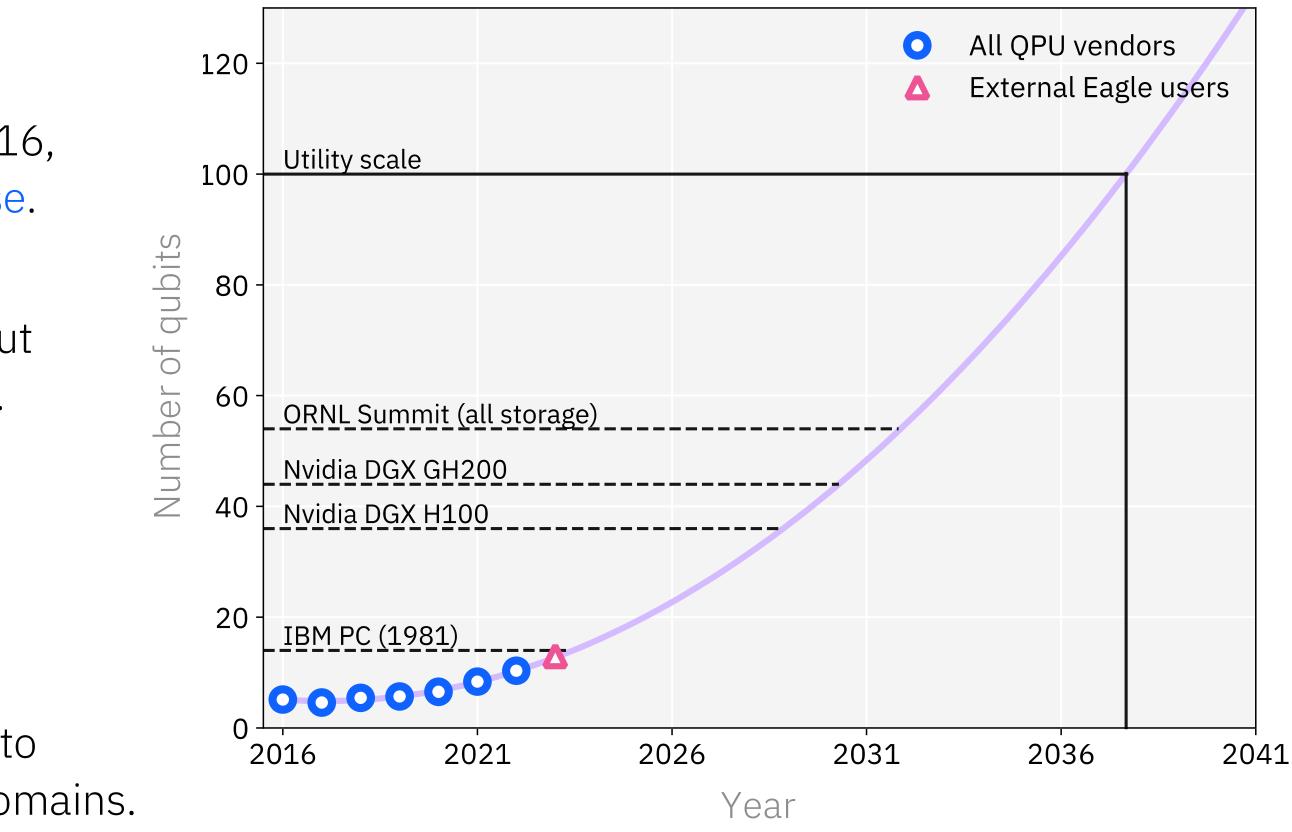
Experiments validate the tenets of quantum computation, but do not push the field beyond the reach of classical compute.

Simulators provide little experimental value; you can't do quantum computing without quantum hardware.

The community needs to move beyond simple experiments to demonstrate the utility of quantum computing in multiple domains.

> This will take too long! We need a disruptive change!

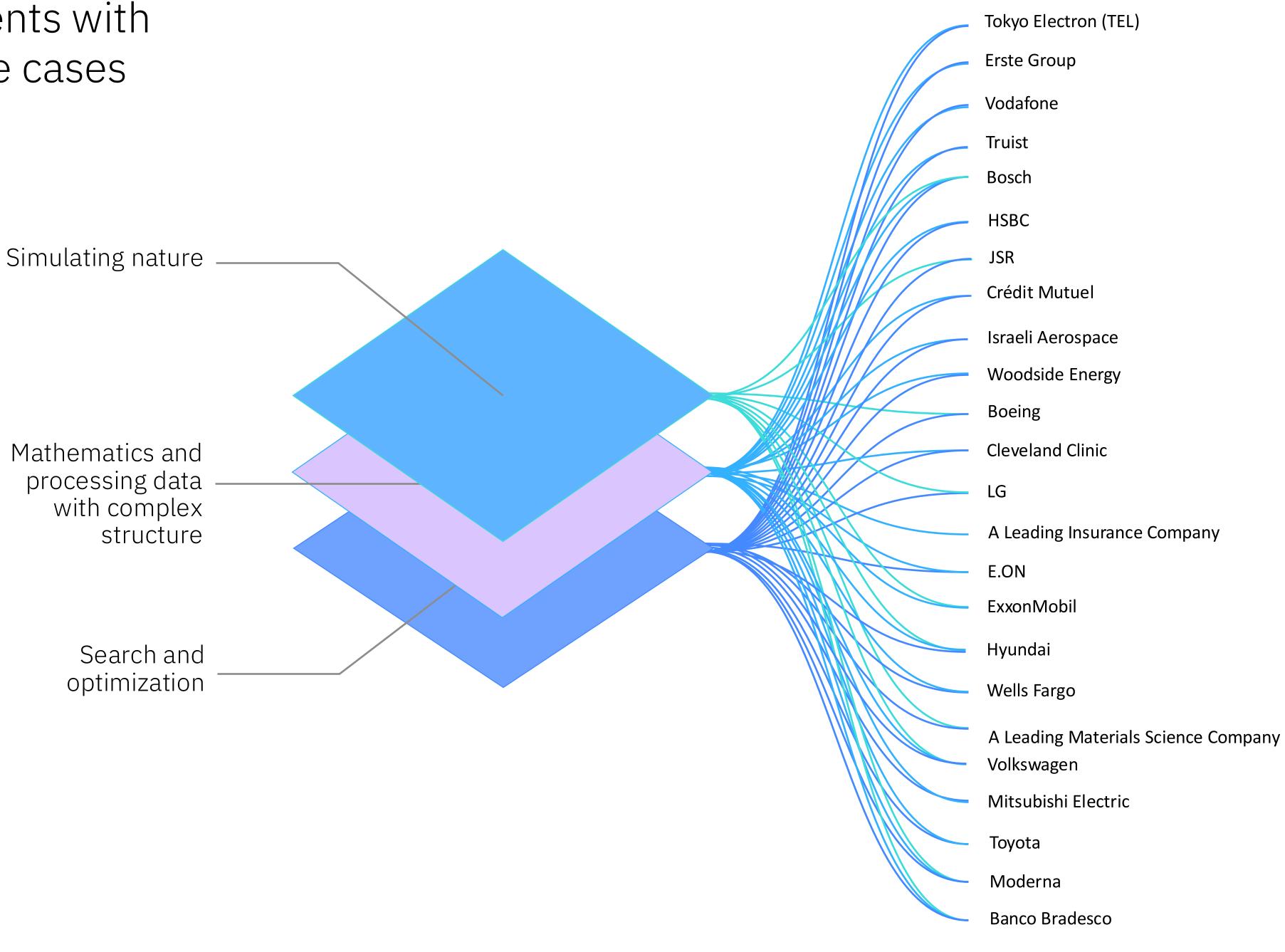
#### Estimated mean number of qubits used on hardware



Data for all vendors taken from: arXiv:2307.16130

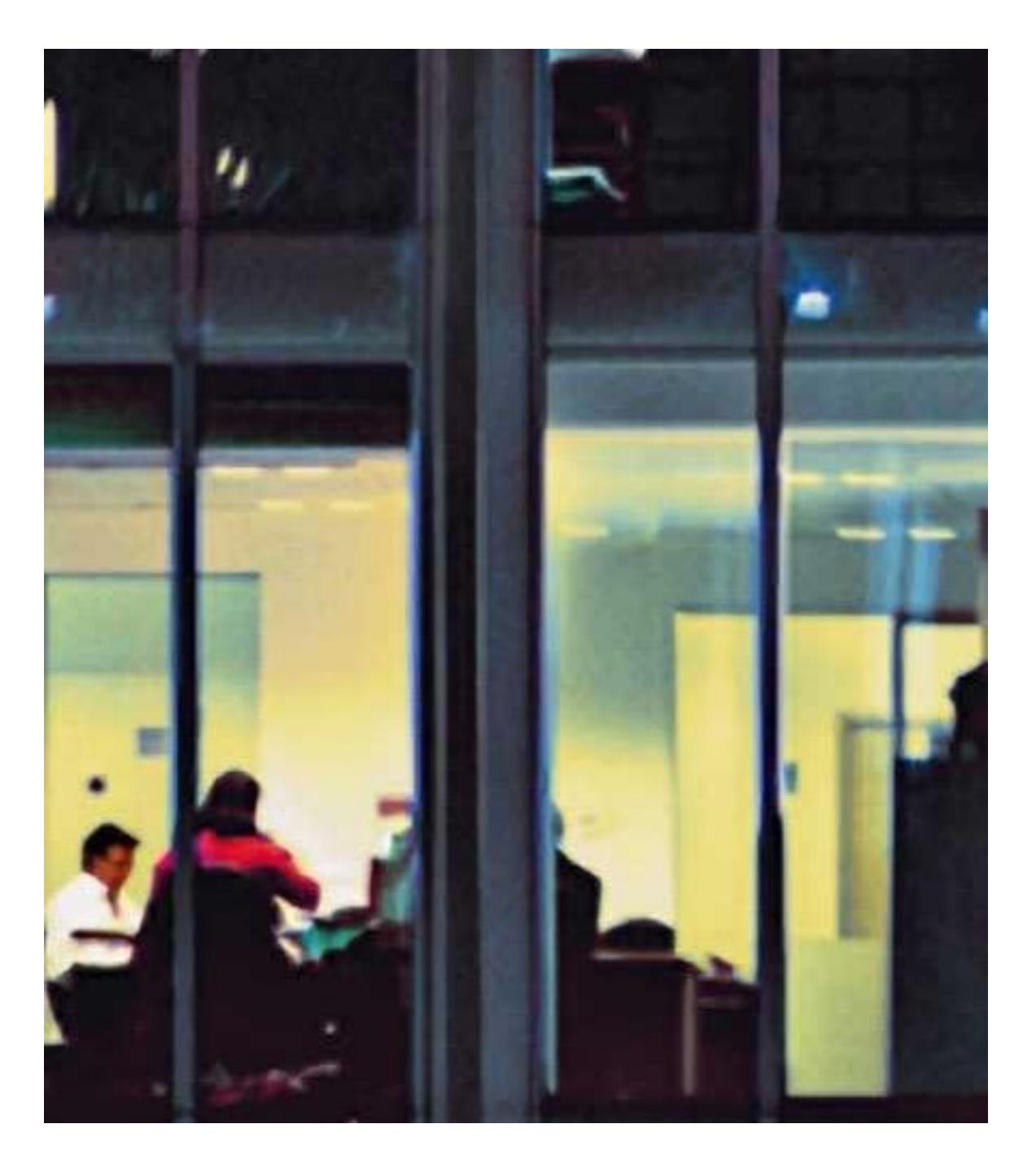
A Quantum Computational Scientist is *not* interested in the quantum machine itself, but rather in utilizing the machine to solve a distinct computational problem.

### Connecting industry clients with quantum computing use cases

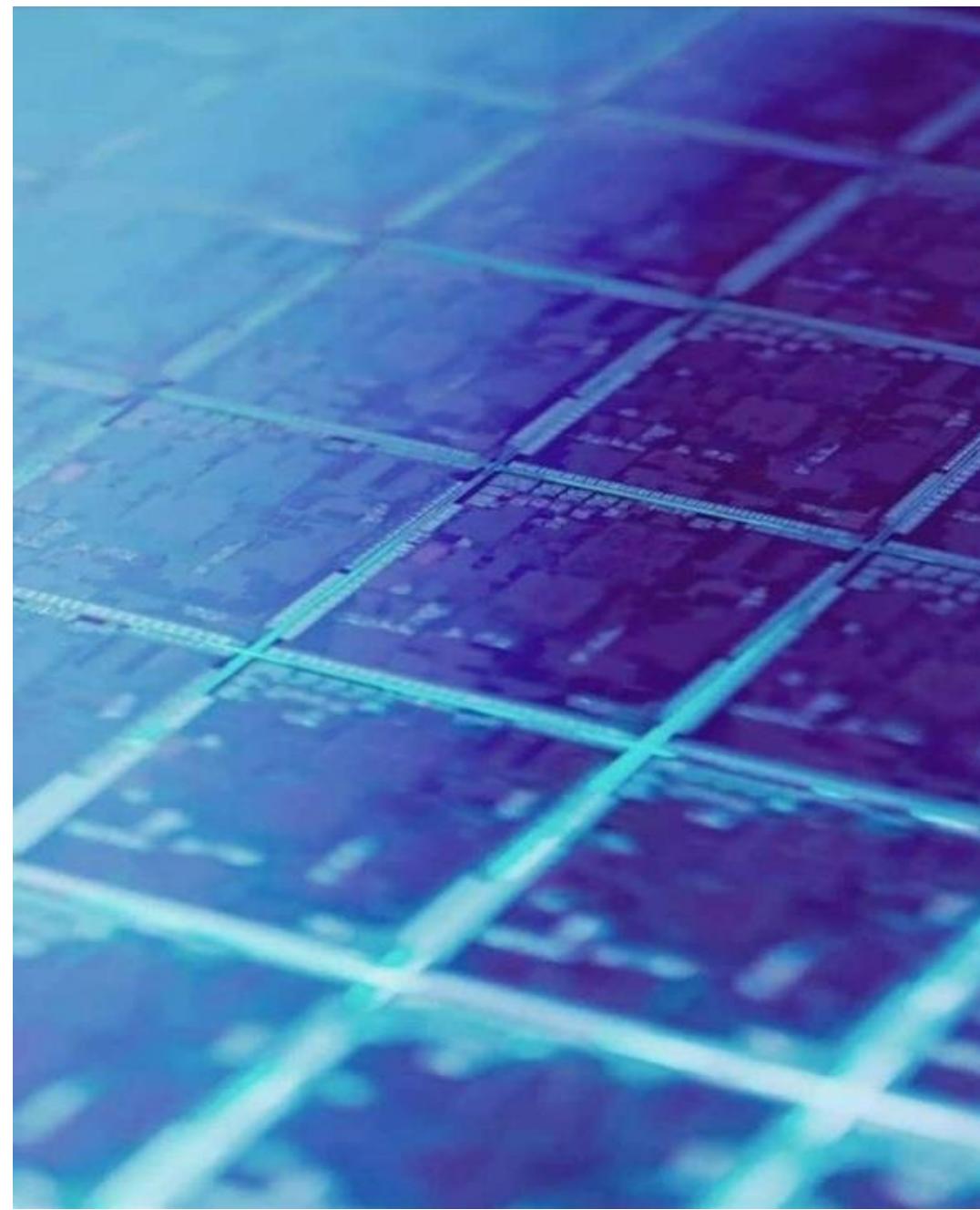


Wells Fargo

- Wells Fargo + IBM Quantum have published more than 10 quantum research papers in recent years.
- These papers explore new kinds of algorithms and new ways of thinking about problems in the financial services industry.
- Research focus on training quantum systems to mimic the probability distributions seen in the real world, then use that system for predictive modeling.



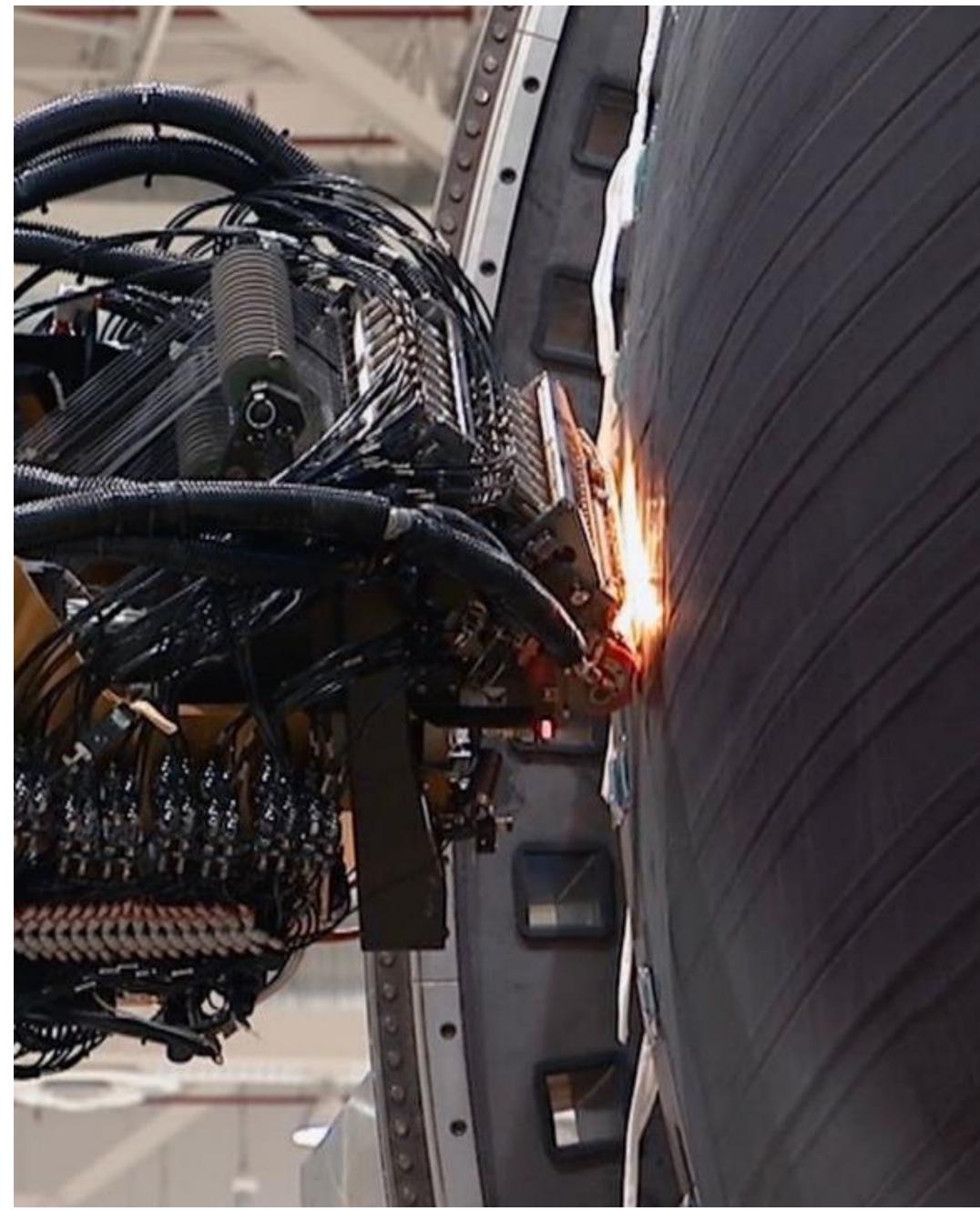
- JSR + IBM are experimenting with chemical simulations to help improve the development and manufacture of photoresists.
- We've already demonstrated that we can simulate small molecules that mimic parts of the photoresist.
- We hope that simulations like these will help us realize even faster chips.







- Boeing + IBM demonstrated a way to create larger computational spaces for simulating new materials.
- The simulations that the team ran are among the most complex quantum optimizations ever run.
- Boeing hopes these simulations will let them design lighter and stronger materials so planes can fly farther with less fuel.





#### ExxonMobil

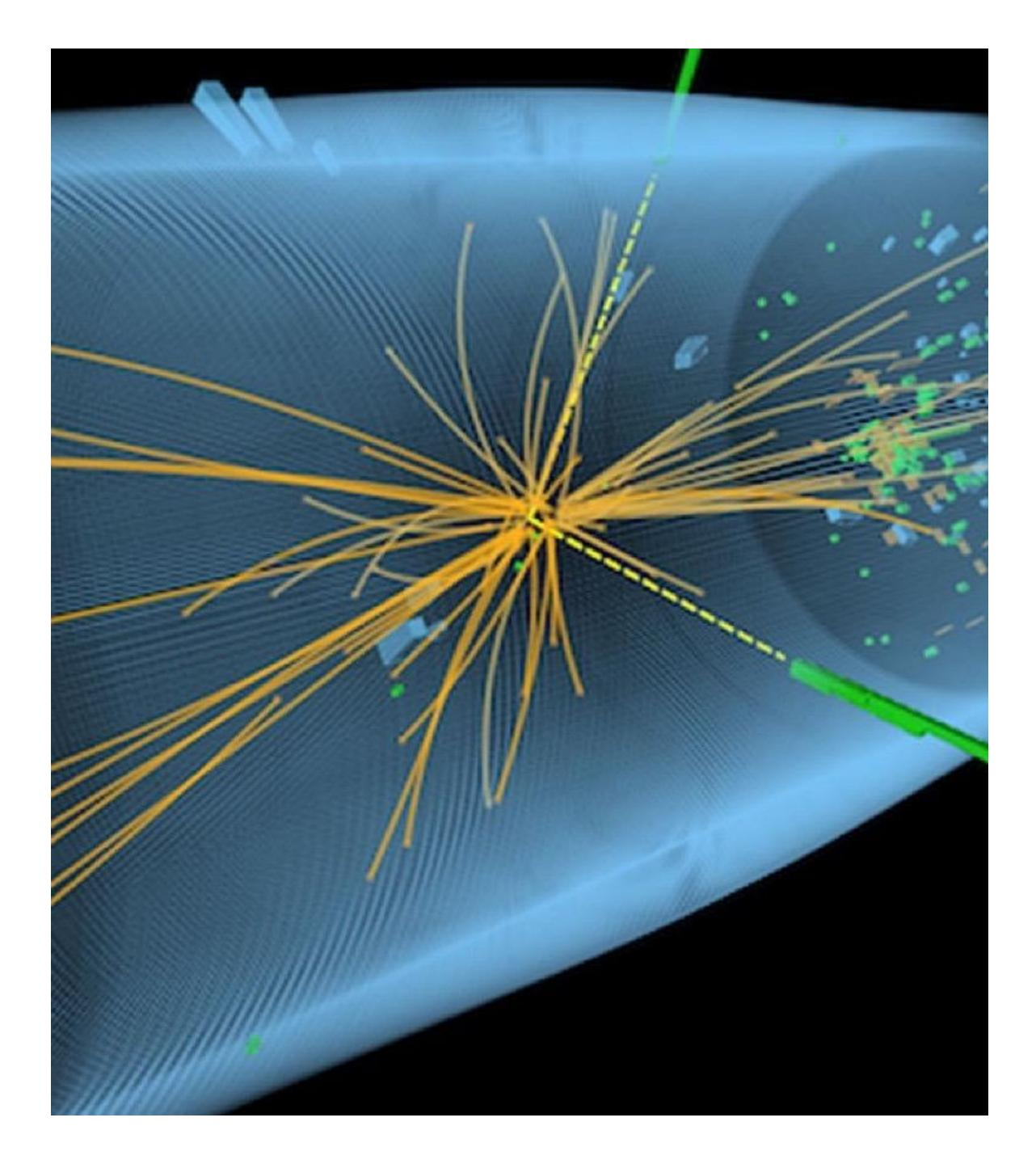
- ExxonMobil + IBM are modeling maritime inventory routing on quantum devices.
- By analyzing different strategies for vehicle and inventory routing they're laying the foundation for constructing practical solutions for their operations.
- More efficient shipping routes could help us transport fuel more efficiently around the globe.







- CERN + IBM are exploring how quantum machine learning algorithms can help find notable events in their vast datasets.
- We're using some of the smallest parts of the universe — the parts we do understand— to learn more about the smallest parts of the universe that we don't understand.



### Development Roadmap

	2016-2019 🛛											
		2020 🥑	2021 🛛	2022 🥑	2023 🥏	2024	2025	2026+	2027	2028	2029	2033+
	Run quantum circuits on the IBM Quantum Platform	Release multi- dimensional roadmap publicly with initial aim focused on scaling	Enhancing quantum execution speed by 100x with Qiskit Runtime	Bring dynamic circuits to unlock more computations	Enhancing quantum execution speed by 5x with quantum serverless and Execution modes	Improving quantum circuit quality and speed to allow 5K gates with parametric circuits	Enhancing quantum circuit quality to allow 7.5K gates	Improving quantum circuits quality to allow 7.5K gates	Improving quantum circuits quality to allow 10K gates	Improving quantum circuits quality to allow 15K gates	Improving quantum circuits quality to allow 100M gates	Beyond 2033, quantum-centric supercomputers will include 1000's of logica qubits unlocking the ful power of quantum computing
Data Scientist						Platform						
						Code assist 🥹	Functions	Mapping Collections	Specific Libraries			General purpose QC libraries
Researchers					Middleware							
					Quantum Serverless	Transpiler 🕑 Service	Resource Management	Circuit Knitting x P	Intelligent Orchestration		Circuit libraries	
Quantum Physicist			Qiskit Runtime									
Thysicist												
Thysicist	IBM Quantum Experience	٢	QASM3 🥥	Dynamic 🥥 circuits	Execution 📀 Modes	Heron <sup>©</sup> (5K)	Flamingo (5K)	Flamingo (7.5K)	Flamingo (10K)	Flamingo (15K)	Starling (100M)	Bluejay (1B)
Thysicist	IBM Quantum Experience	© Falcon	QASM3 📀			<ul> <li>✓</li> <li>✓</li> <li>Heron</li> <li>(5K)</li> <li>Error Mitigation</li> </ul>	Flamingo (5K) Error Mitigation	Flamingo (7.5K) Error Mitigation	Flamingo (10K) Error Mitigation	Flamingo (15K) Error Mitigation	COMPANY OF A DESCRIPTION OF A DESCRIPTIO	Bluejay (1B) Error correction
Executed by IBM			QASM3	circuits	Modes	(5K)	(5K)	(7.5K)	(10K)	(15K)	(100M)	(1B)



d 2033, um-centric computers will e 1000's of logical s unlocking the full r of quantum iting



#### Dedicated Service

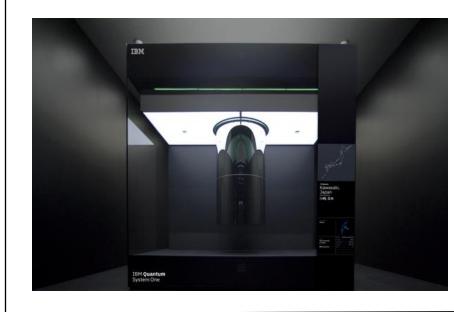
#### Fraunhofer

Ehningen, Germany Dec 2020



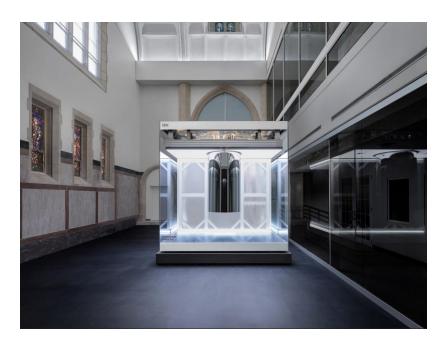
#### University of Tokyo

Shin-Kawasaki, Japan June 2021



#### Rensselaer Polytechnic

Troy, New York April 2024



#### Yonsei University

Seoul, South Korea Projected May 2024



#### **Cleveland Clinic** Ohio, USA

March 2023



**PINQ <sup>2</sup>** Sherbrooke, Canada Sept. 2023



#### Ikerbasque

San Sebastián, Spain Projected Jun 2025



**Riken** Kobe, Japan Projected May 2025





# IBM Quantum