river lane

Quantum Computing – An Industry Insight

Quantum computing will start an era of human progress as significant as the industrial and digital revolutions.

Healthcare
Drug Discovery
Personalised Medicine

AstraZeneca *

Manufacturing
Advanced Materials
Industrial Processes

MERCK *

Climate
Batteries
Carbon Capture

JM *

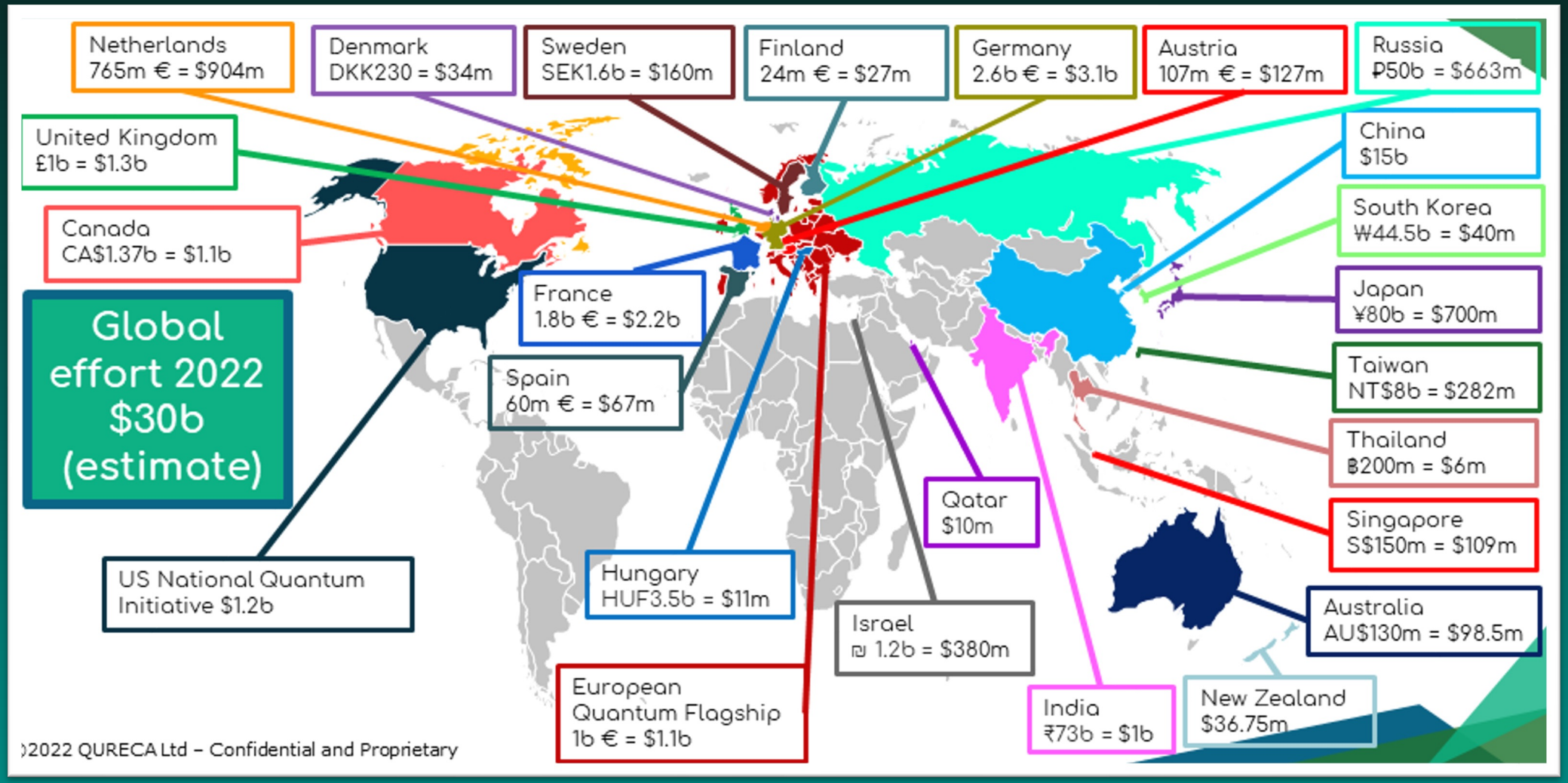
Transportation
Automotive
Logistics

ROLLS ROYCE *

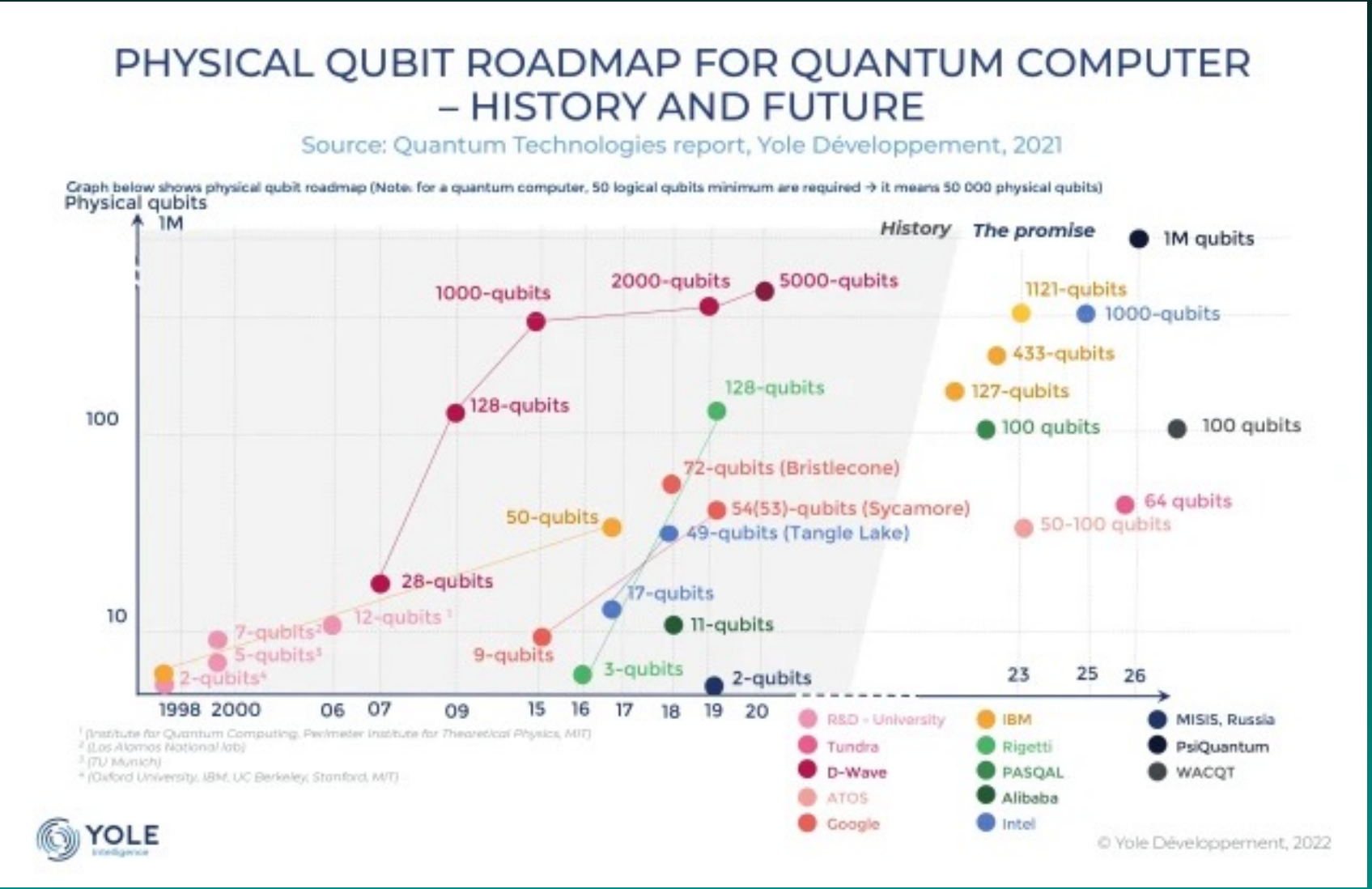
* Existing Riverlane customer

Quantum computers are here to stay

>1: Investments

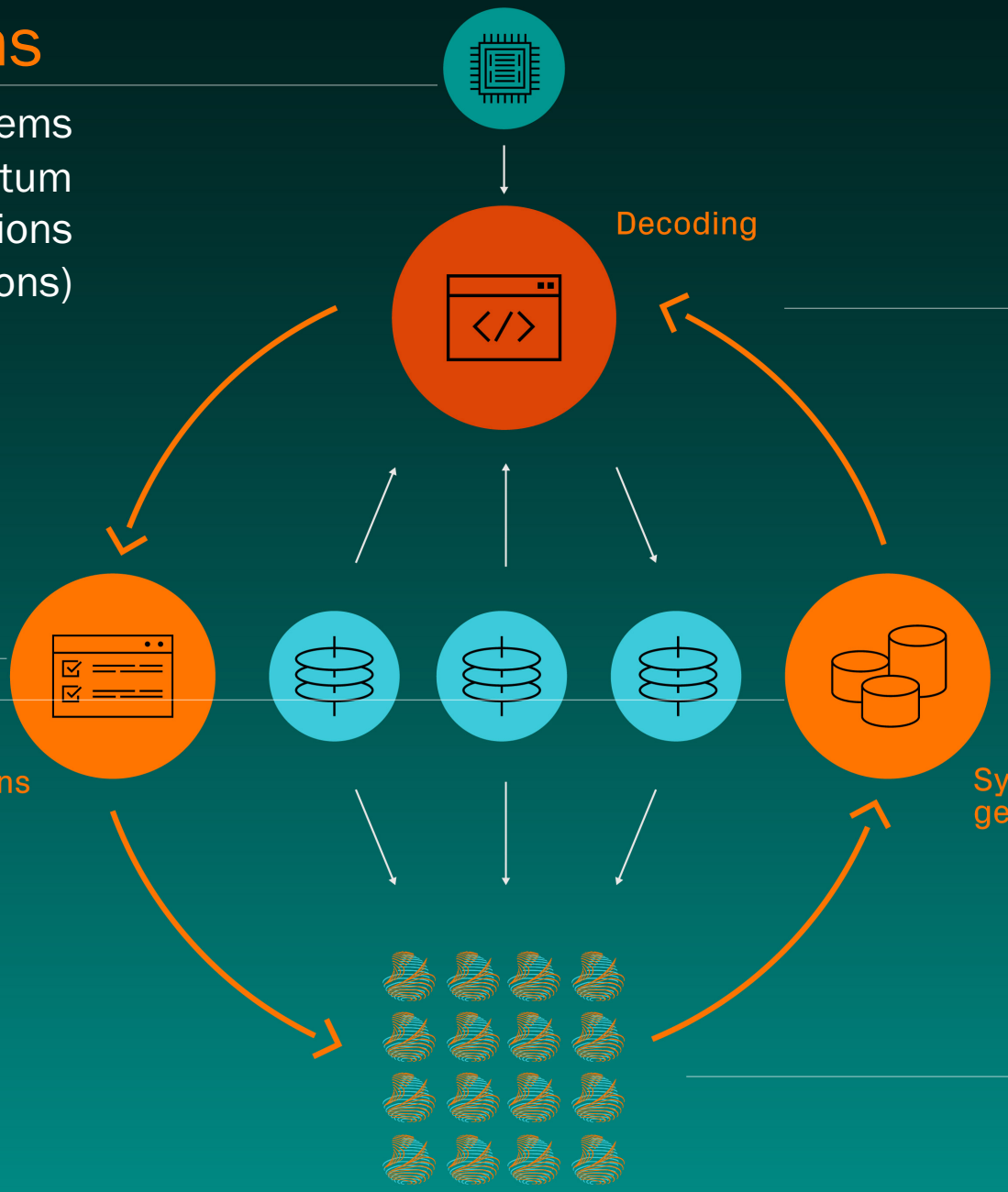


>2: Hardware Solutions



>3: Software Solutions

Map problems into Quantum operations (Applications)



Extend Qubits lifespan (Decode)

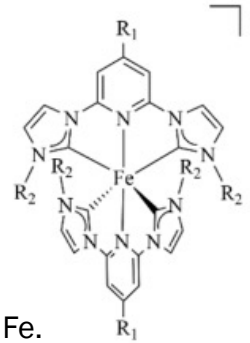
Modify and measure Qubits state (Control)

Generate Qubits (QPU)

The Quantum Software Industry: a deep dive

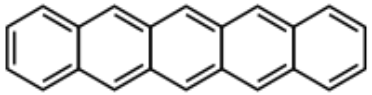
If we want in 10 years to solve hard problems …

Iron-Carbene complex



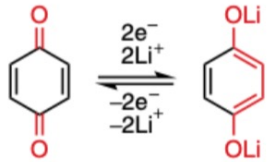
Important for **solar cells**. Replacing expensive and highly toxic Ru in photosensitizers by earth-abundant Fe.

Pentacene

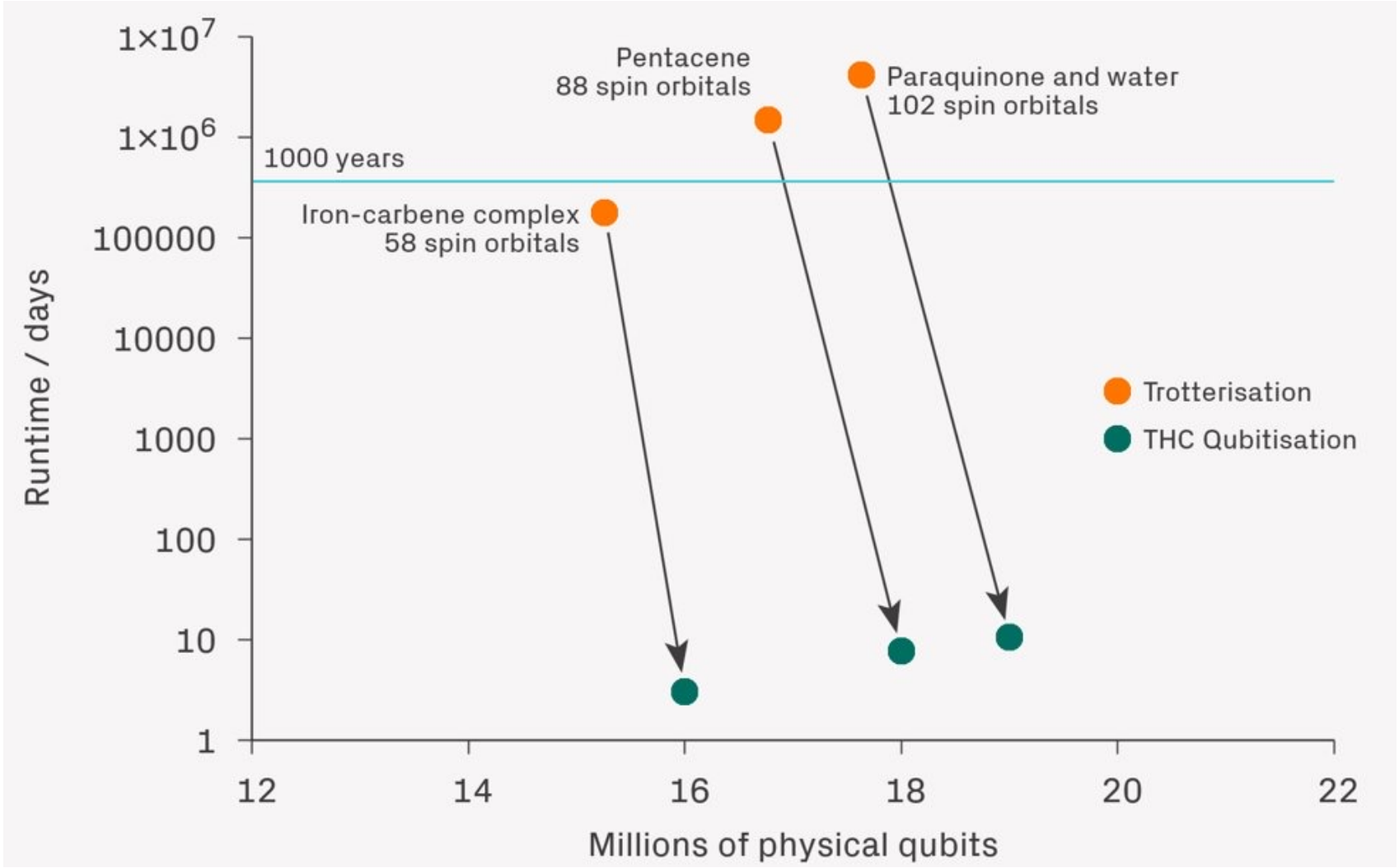


Important for **solar cells**. A possible way to improve efficiency through singlet fission.

Para-quinone

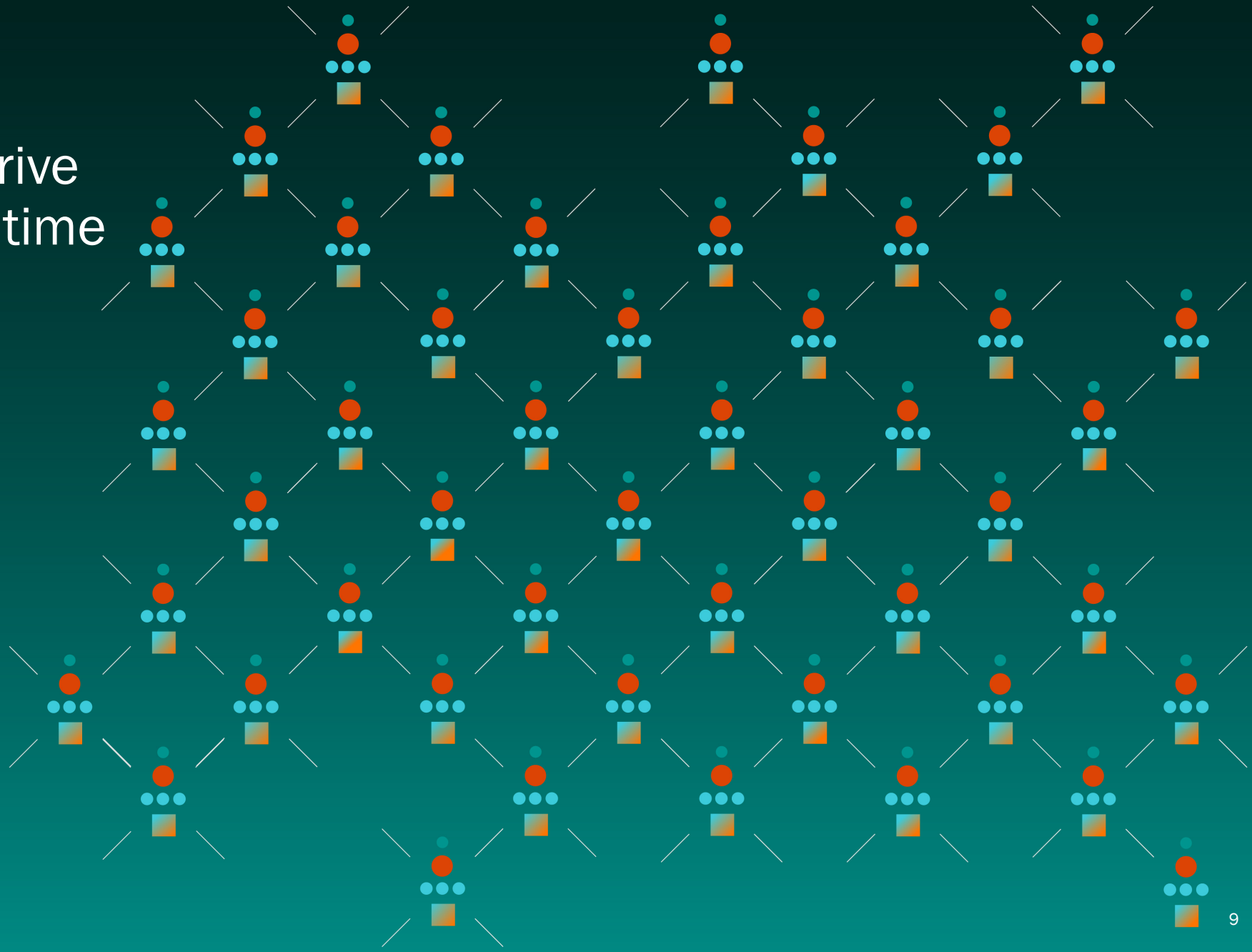


Important for **batteries**. Organic electrodes are sustainable materials for batteries, to reduce use of Cobalt.



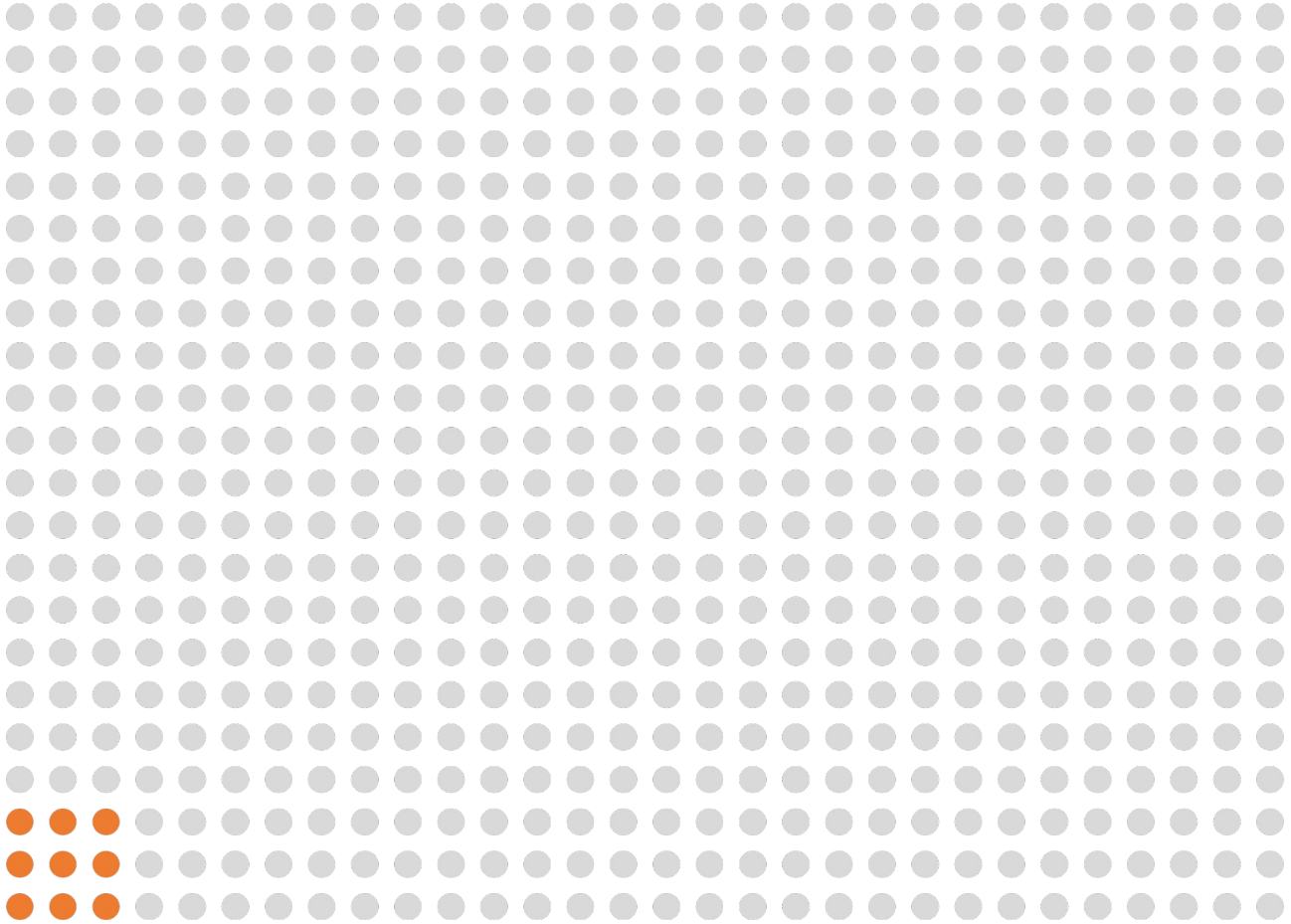
>Challenge 1

We need to finely drive 1000+ of qubits at time



>Challenge 2

Make every qubit count and make it live for as long as possible



With Deltaflow.OS

Current system size needed for fault tolerant quantum computing

How?


Applications
Materials
Pharmaceuticals
Clean Energy
Aerospace
Deltaflow.OS®
System Tools
Decoders
Runtime
Control System
Control Hardware
Qubits

>Challenge 1

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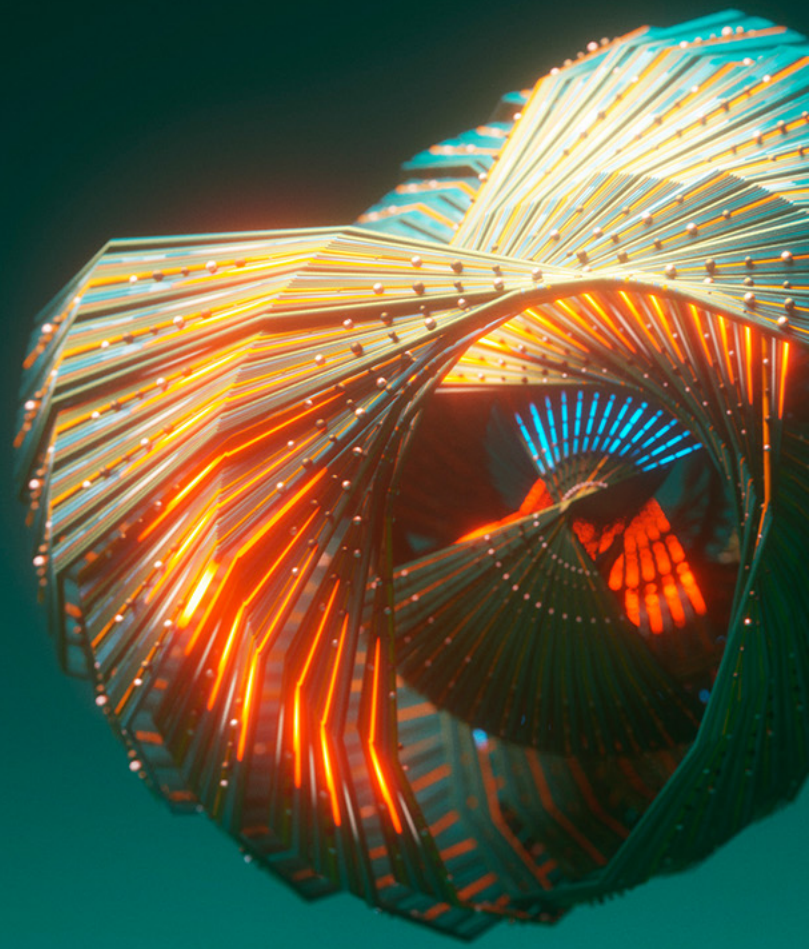
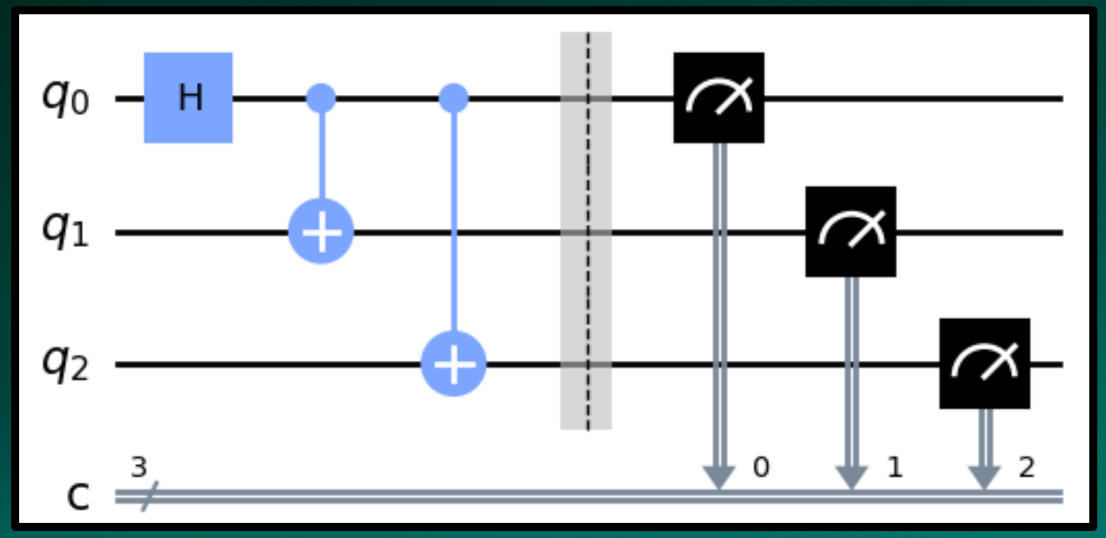
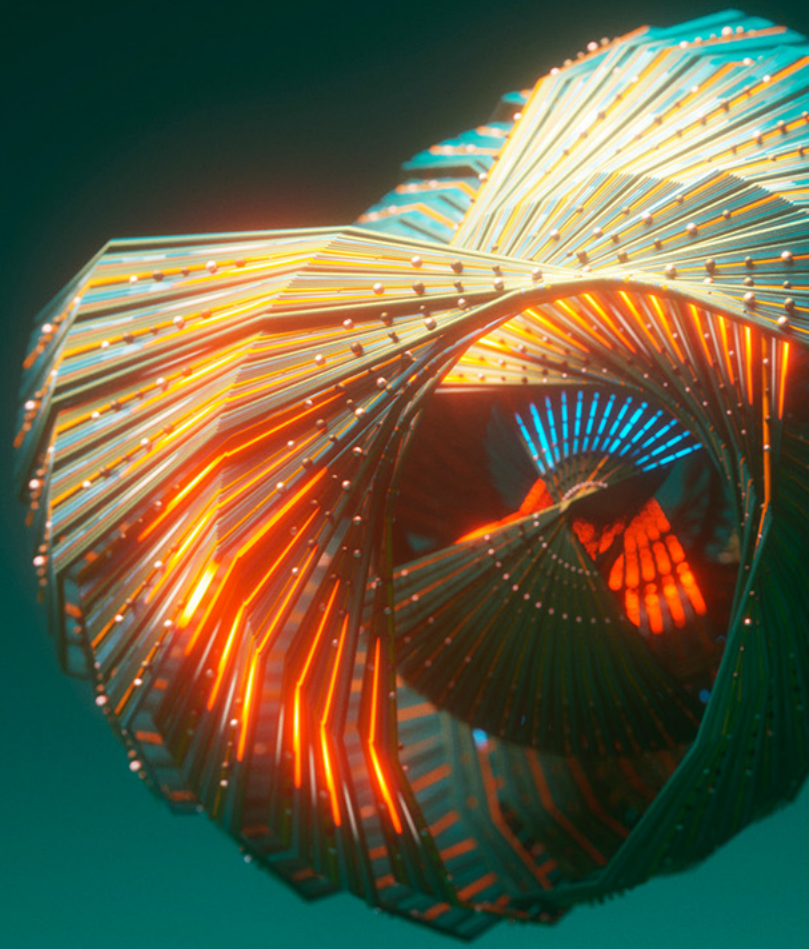
1000+ of qubits at time



How do you control a quantum computer?

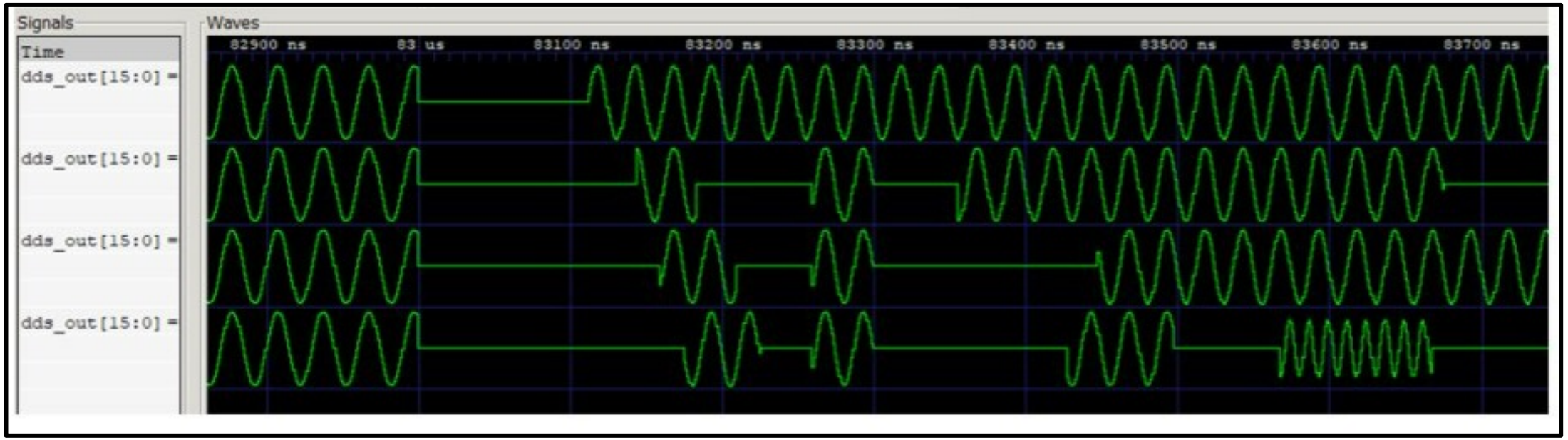
- Quantum information is manipulated using combinations of gate operations on the qubits.
- This is called a “quantum circuit”.





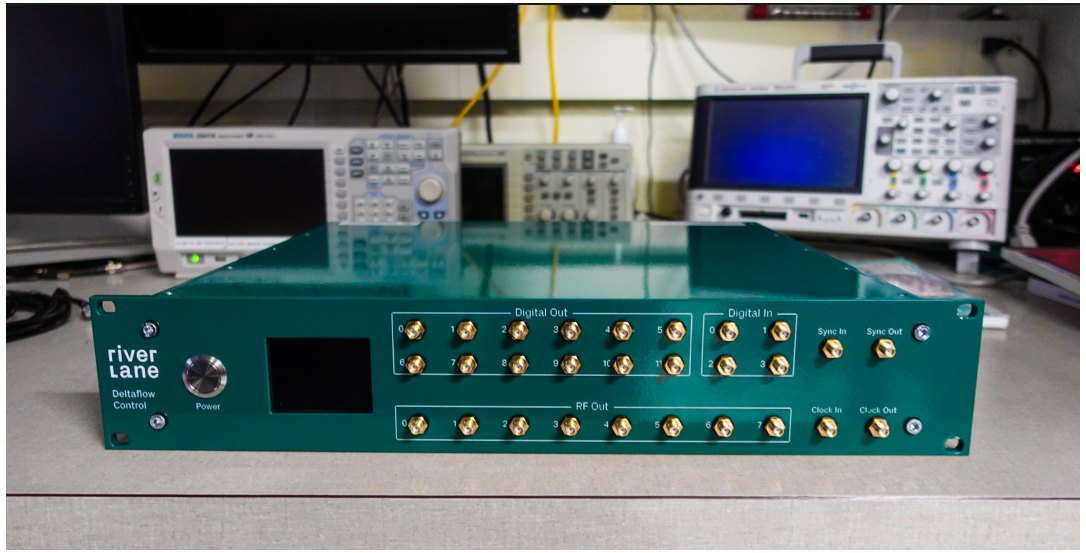
How do you control a quantum computer?

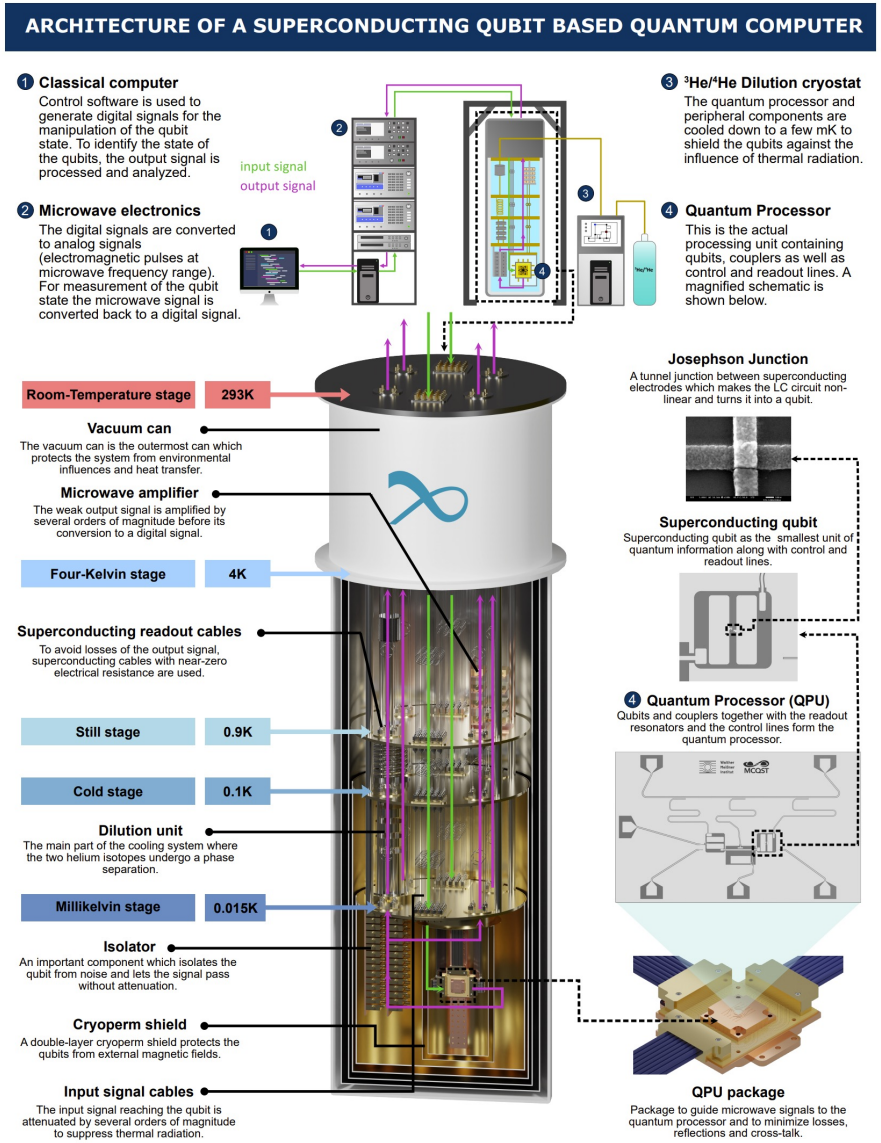
- The quantum circuit is compiled down into a **pulse schedule.**
- These microwave pulses perform gate operations by acting on qubits.



How do you control a quantum computer?

And everything needs to be economically viable to allow large scale systems





Walther-Meißner-Institut DER BAYERISCHEN AKADEMIE DER WISSENSCHAFTEN | MUNIQC-SC Quantum Computing Demonstrator Superconducting Qubits | Munich Quantum Valley | MCQST

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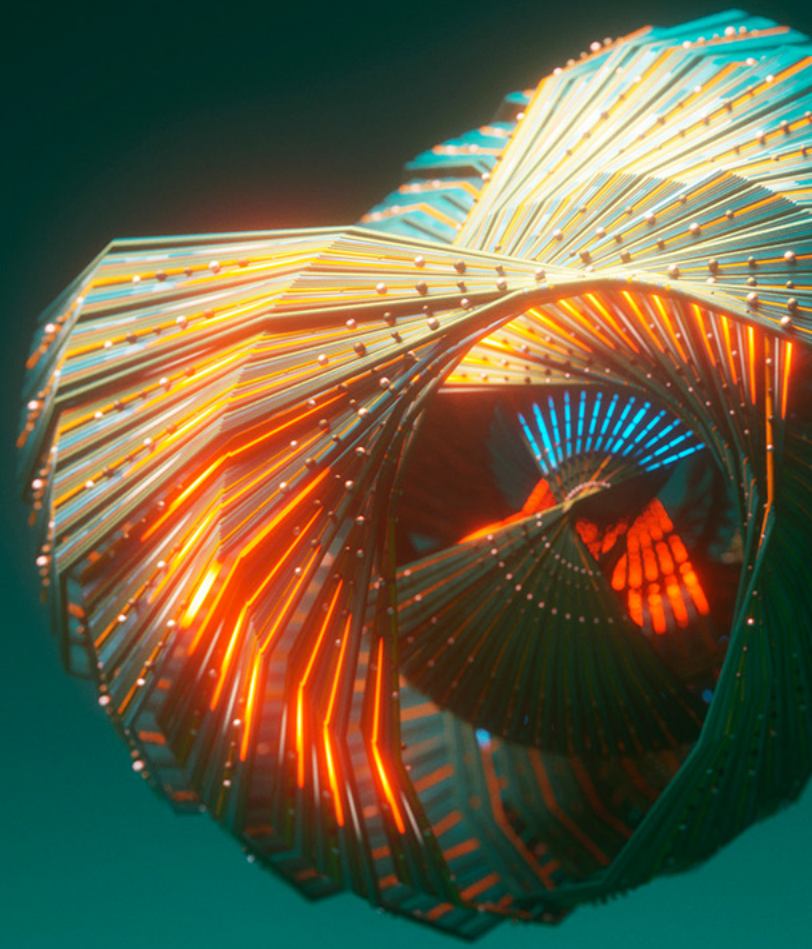
>Challenge 2

Make every qubit count and make it live for as long as possible

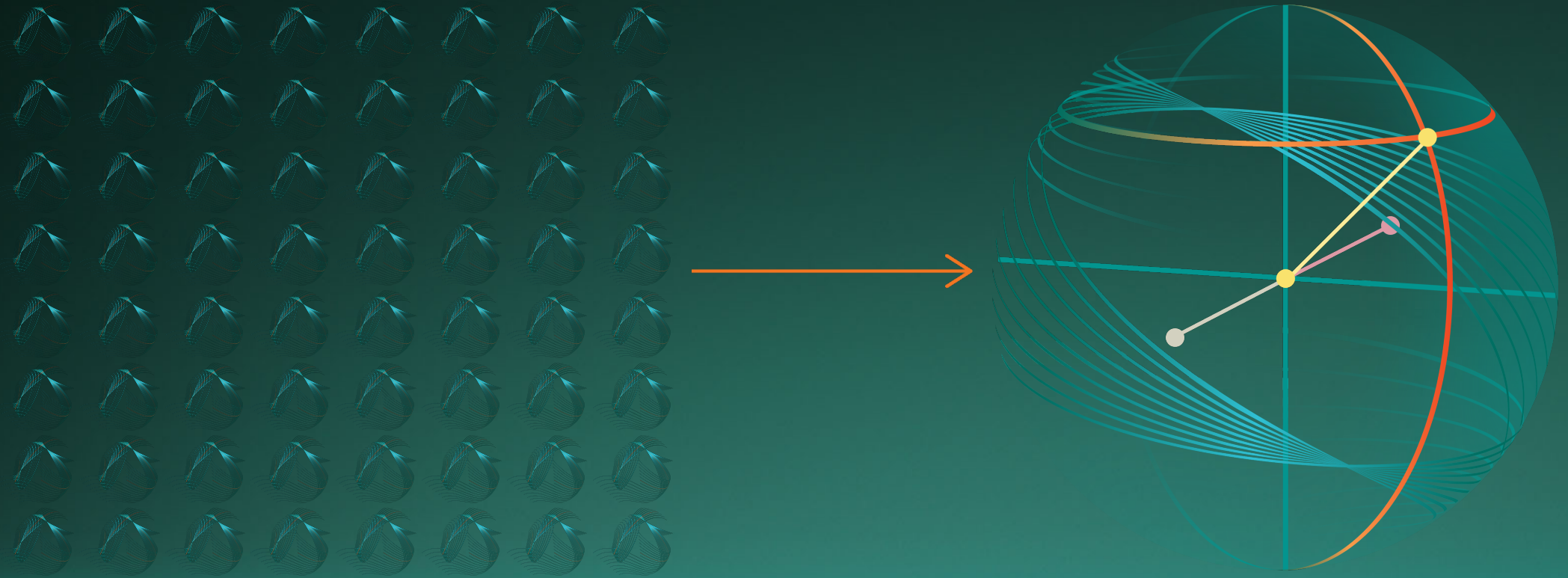


Qubits are fragile and susceptible to noise which causes decoherence...

- Decoherence

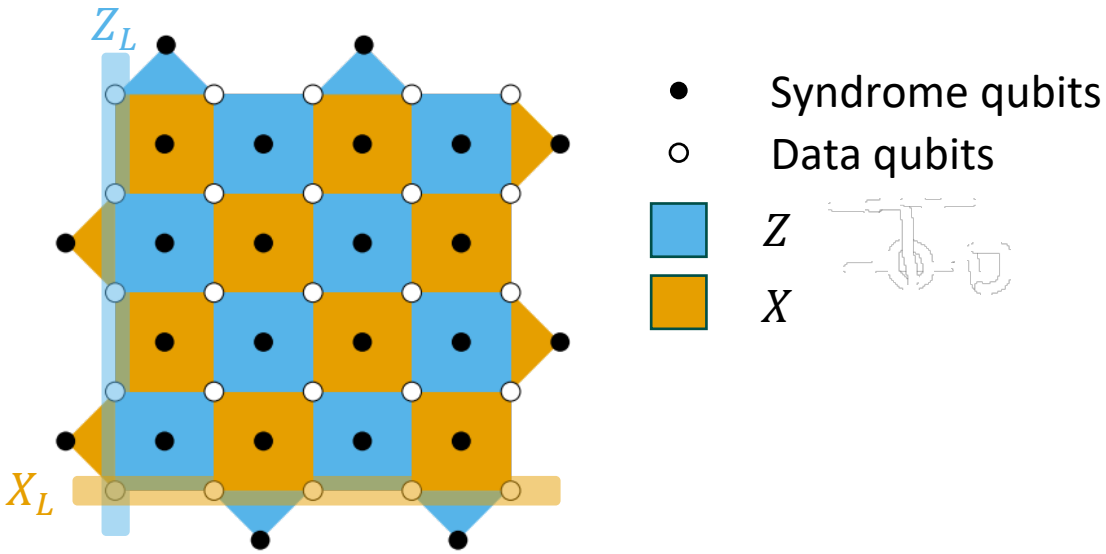
Corrected quibit

Quantum error correction is how we create logical qubits from many noisy qubits

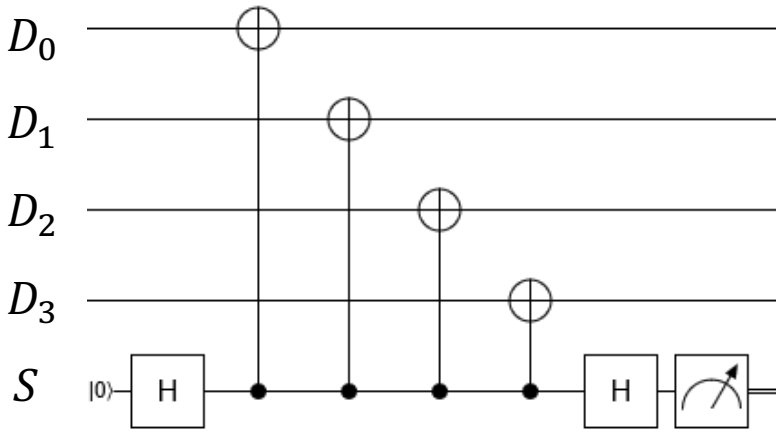


The surface code

Surface code error correction is performed by measuring “checks” that look (or check) for errors



A circuit to measure one “check”



Measuring all the surface code “checks” once is called 1 QEC round

In semiconducting devices, this takes 10-100us

What happens if we are not fast enough?

- $10\mu s$ semiconducting QEC time

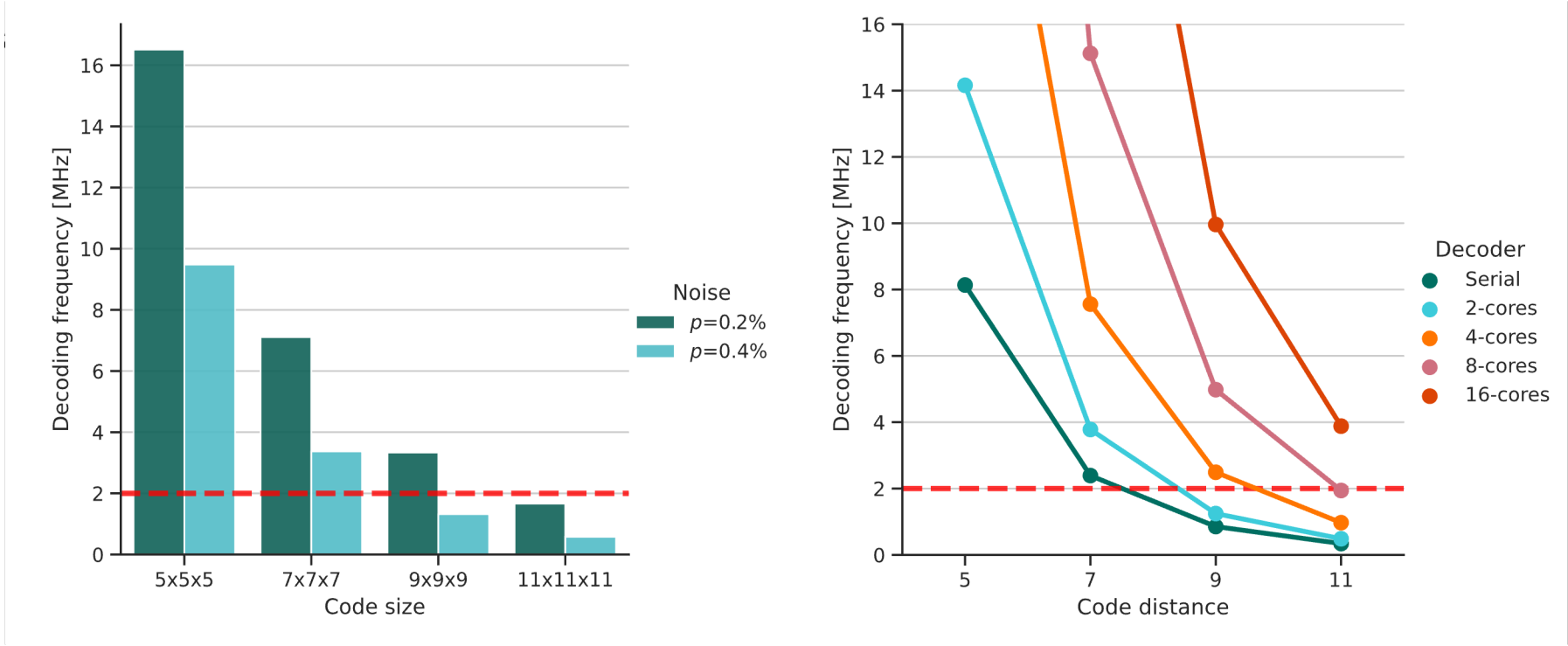
  For FeMoco simulation need 10^{10} gates → ~ 10 days
  Say decoder takes $10.1\mu s$/round $(f = 1.01)$
  With lag: 10^{10} gates $\approx 1.01^{10^{10}} s \gg$ Age of the Universe

- Decoders take longer for bigger codes.
- For n qubit codes most decoders satisfy $f = \Omega(n)$

Longer computation ⇒ need bigger codes ⇒ slower decoding ⇒ BACKLOG PROBLEM

There is a max limit on the size of quantum algorithms we can execute.

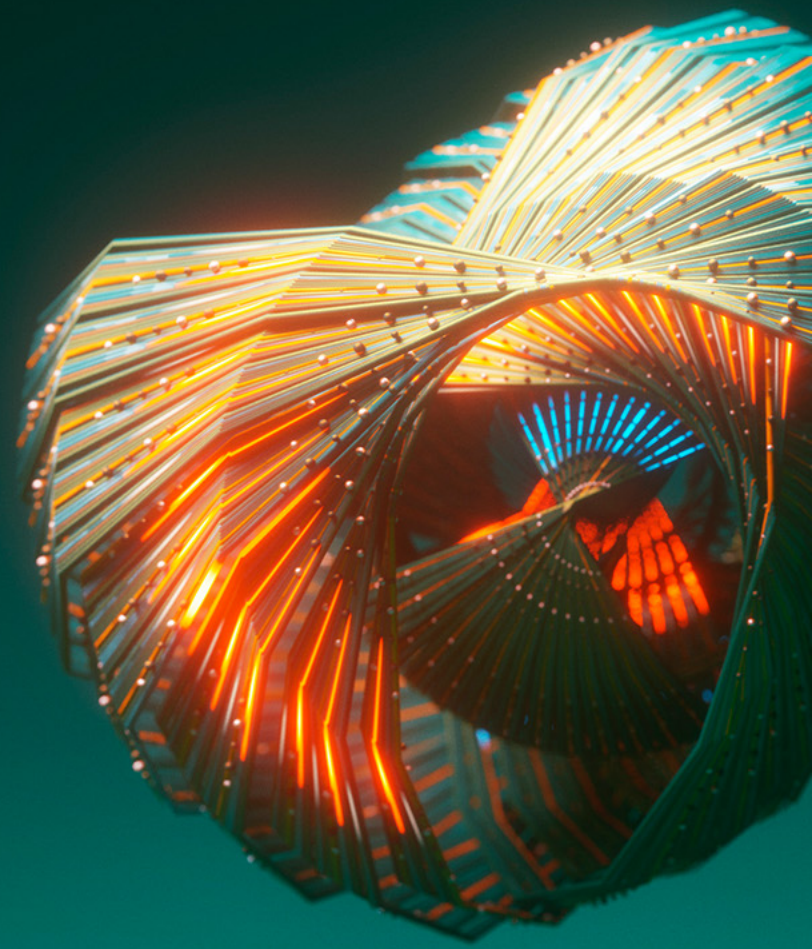
Then, let’s be fast enough



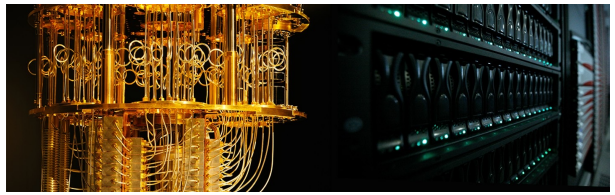
Riverlane Team, Deltaflow.Decode Technical White Paper,
https://www.riverlane.com/app/uploads/2022/09/Deltaflow_Decode_Technical_White_Paper_September_2022.pdf

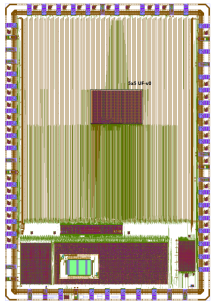
>Putting it together

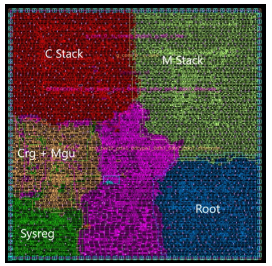
We need to finely drive 1000+ of qubits at time whilst decoding for errors at-speed

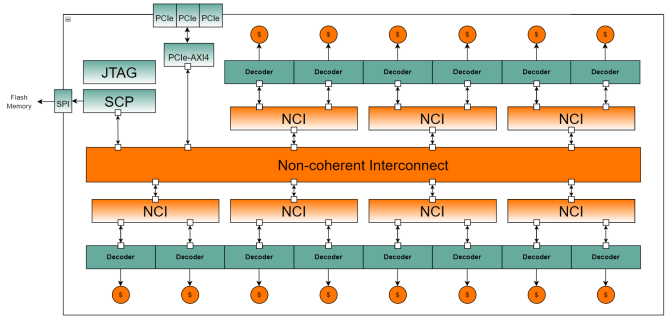


Riverlane strategy.









Guide the market and build expertise

Integrate in state-of-the-art solutions

Provide full-scale commercial solutions

There are many ways to build
a quantum computer but only
one way to make them useful:

>Deltaflow.OS _