

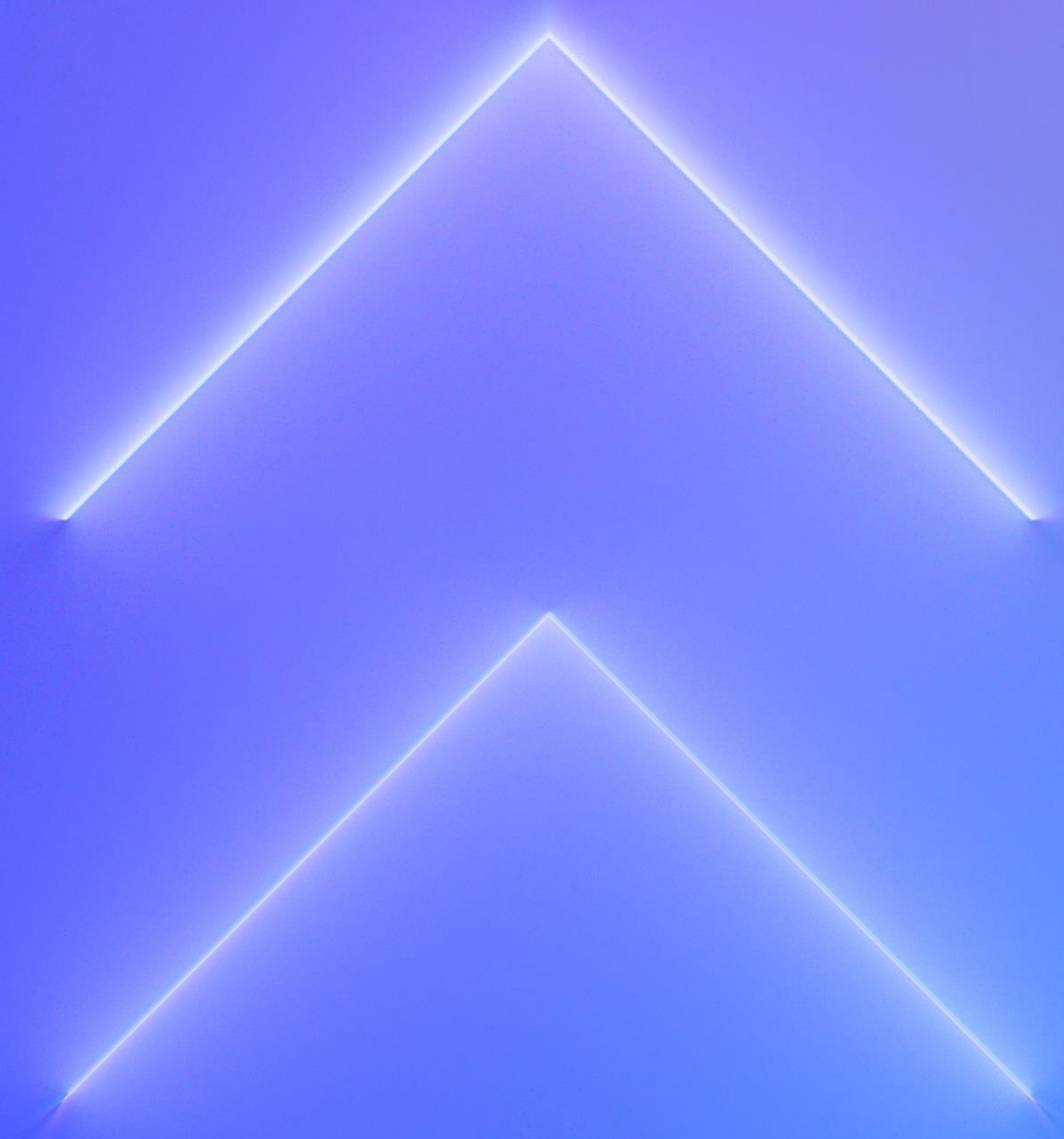


A software framework for creating and running QEC experiments in simulation and on quantum devices

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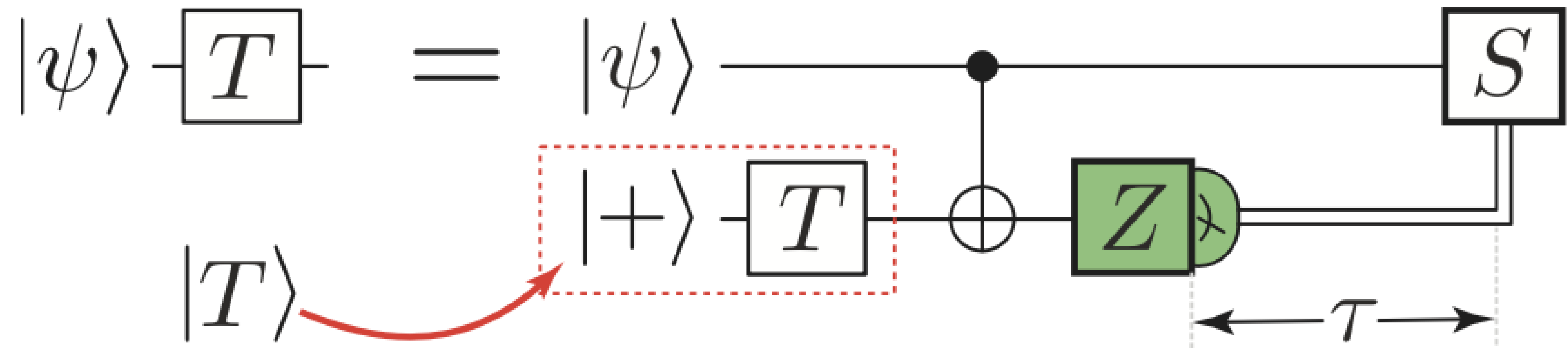
¹: Riverlane, Cambridge, CB2 3BZ, UK

²: Work done while at Riverlane



Universal computation in QEC

Where low latency is important

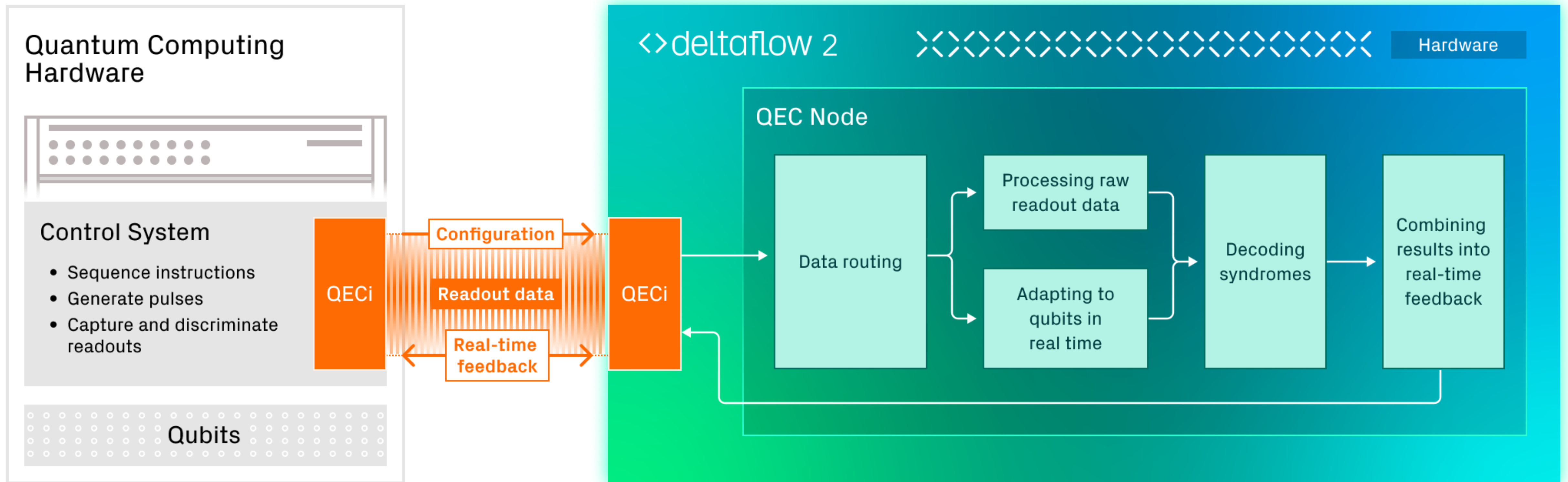


<> deltaflow

Real-time quantum error correction system accelerating the world's quantum computers to utility scale

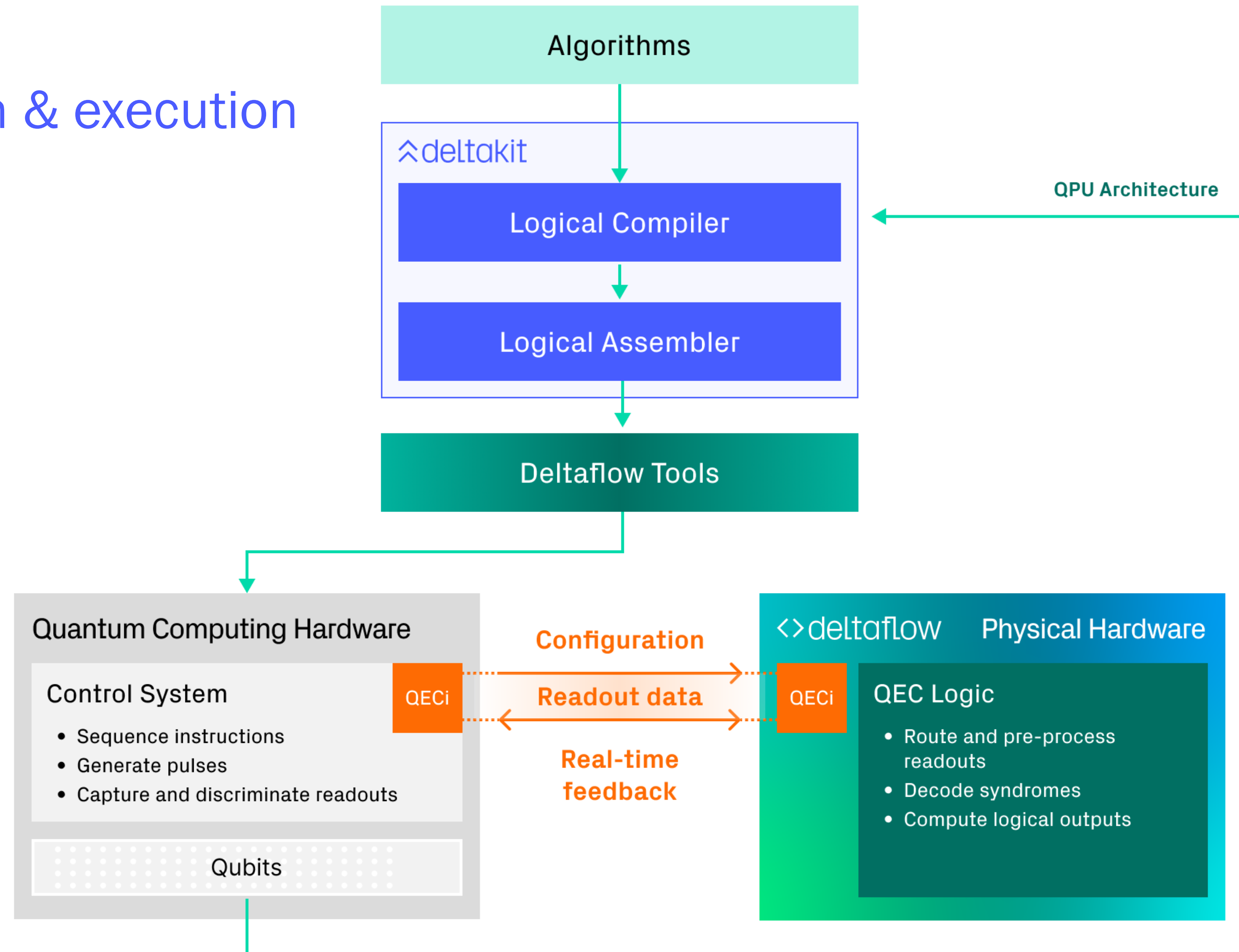


Universal computation in QEC



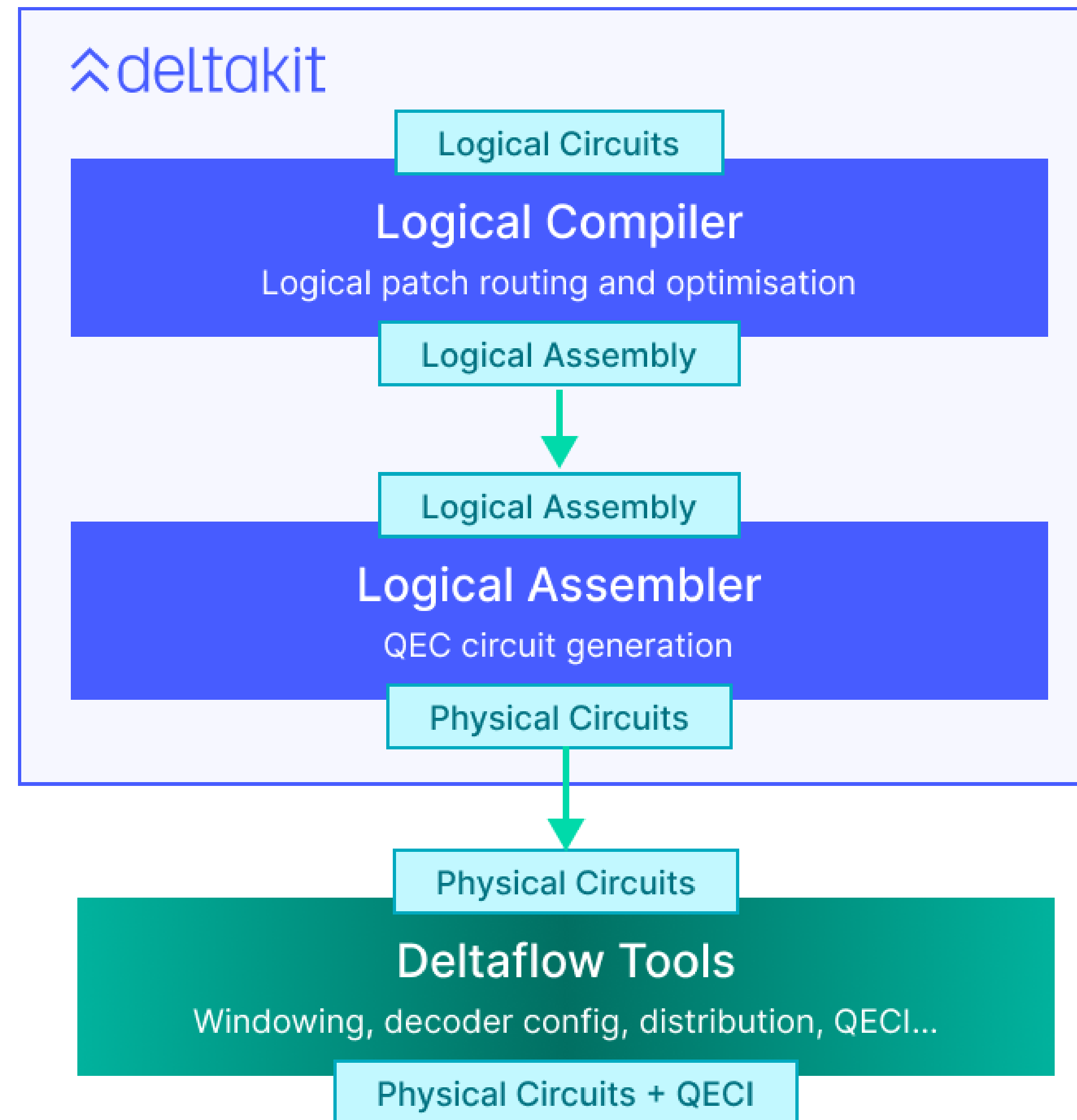
Riverlane's stack

Program generation & execution



Riverlane's stack

Program generation & execution

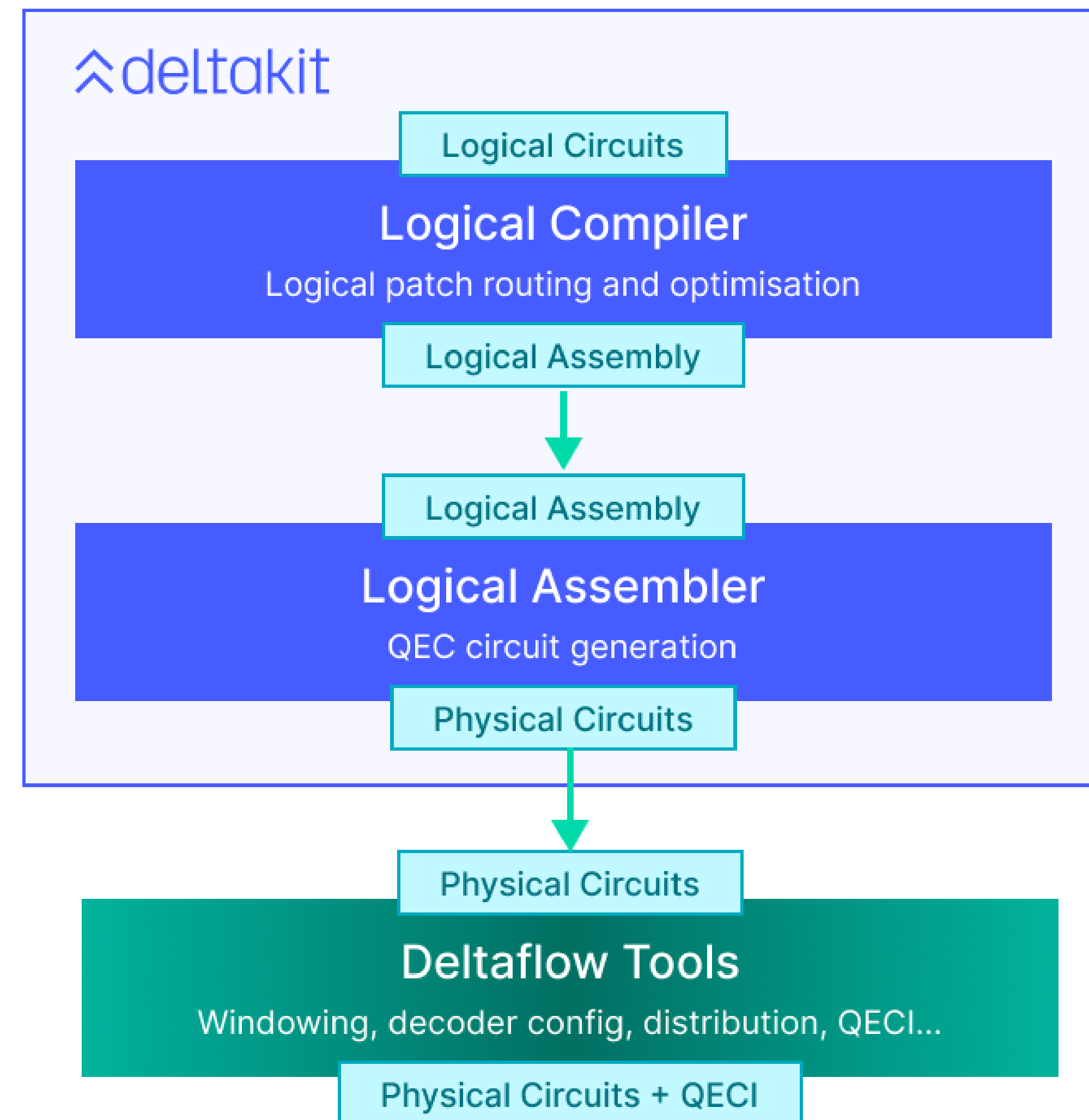


Riverlane's stack

Program generation



- Compiler architecture (inspired by MLIR)
- Python framework (xDSL)
- From logical programs to control-system instructions



Riverlane's stack

Example of API

Logical assembly

```
1 d = 5
2 builder = LogAsmBuilder()
3 p0 = builder.declare_patch(RotatedPlanarPatch(d, d))
4 p1 = builder.declare_patch(RotatedPlanarPatch(d, d))
5
6 p0.prepare(Z)
7 p1.prepare(Z)
8 p0.measure_stabilisers(8 * d)
9 p1.measure_stabilisers(8 * d)
10
11 b0 = p0.measure(Z)
12 with builder.if_(b0 == 1):
13     p1.transversal(X)
14
15 b1 = p1.measure(Z)
16 builder.add_returns(b0, b1)
17
18 Compiler().compile(builder.build())
```

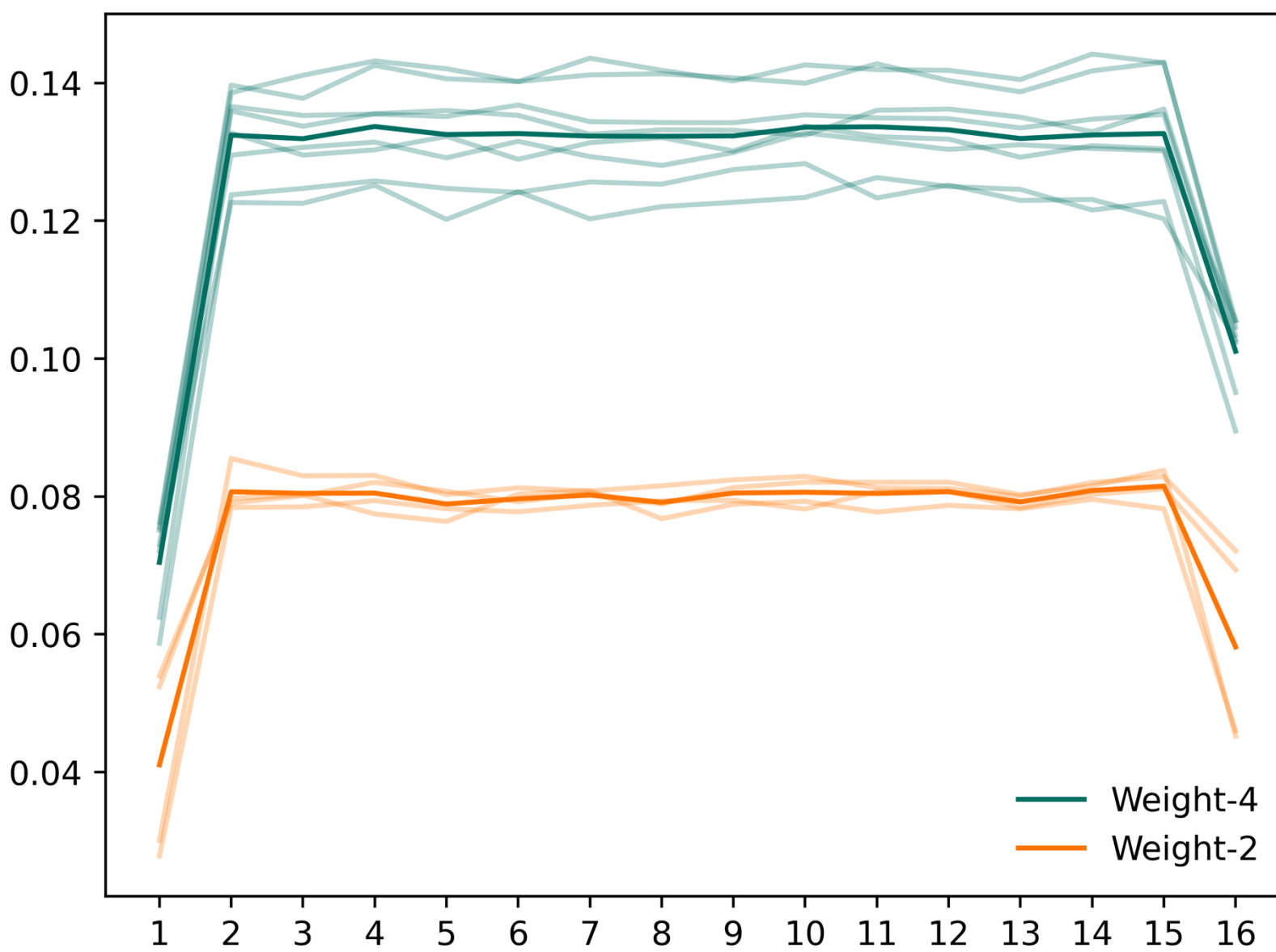
Circuit

```
1 # Declarations
2 builder = CircuitBuilder()
3 qubits = builder.add_args(QubitReg(9))
4 recs = [builder.declare_record() for _ in range(4)]
5 # Circuit
6 builder.gate("R", qubits)
7 builder.gate("CX", qubits[:-1])
8 builder.gate("CX", [qubits[i] for i in (2, 1, 4, 3, 6, 5, 8, 7)])
9 readouts = builder.measure(Pauli.Z, [qubits[i] for i in (1, 3, 5, 7)])
10 # Records and detectors
11 ✓ for i in range(4):
12     recs[i].append(readouts[i])
13 repetition_5_prep = builder.build()
14
15 logical_builder = LogAsmBuilder()
16 qreg = logical_builder.add_arg(QubitReg(9))
17 logical_builder.call_circuit(repetition_5_prep(qreg))
```

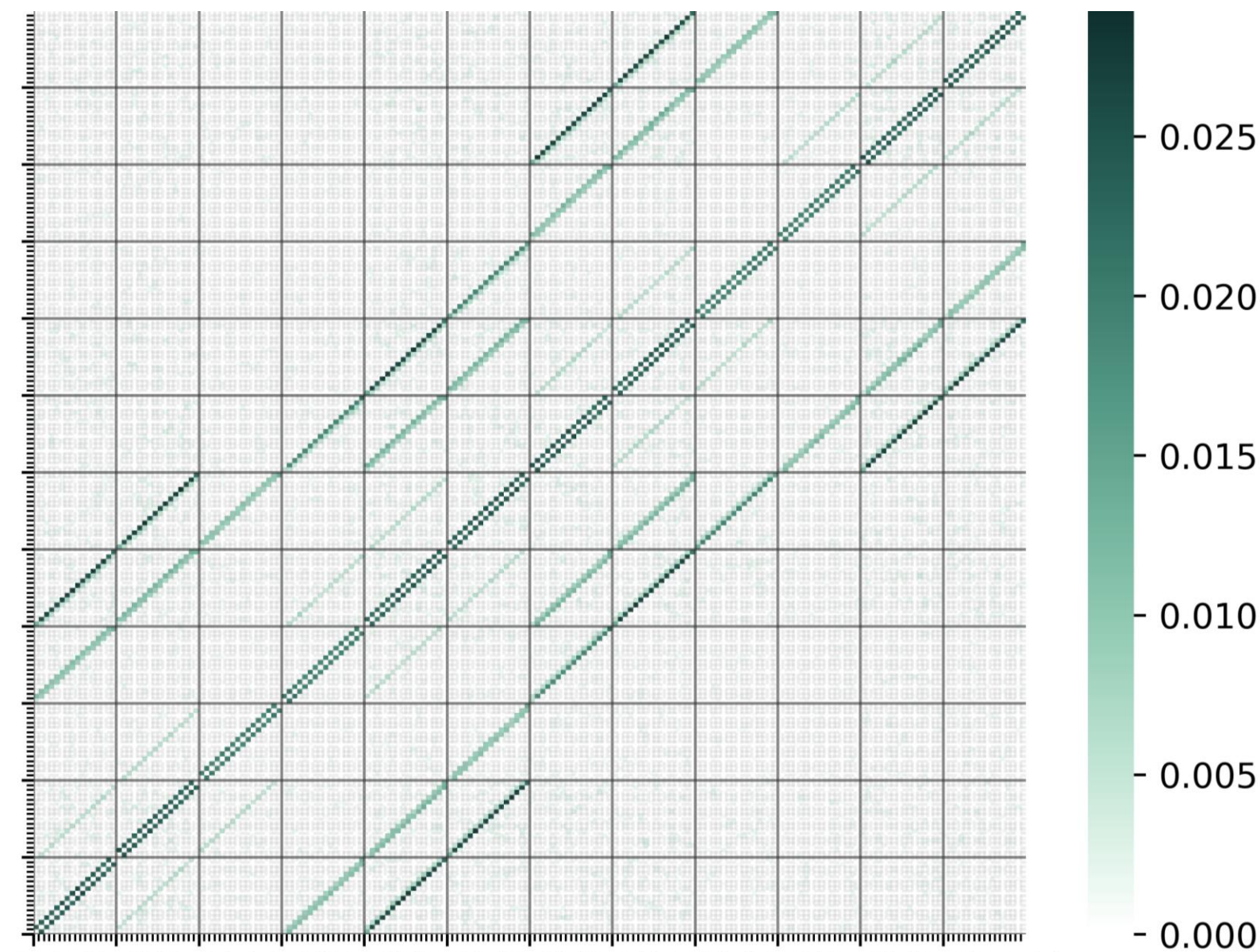

Riverlane's stack

Result analysis

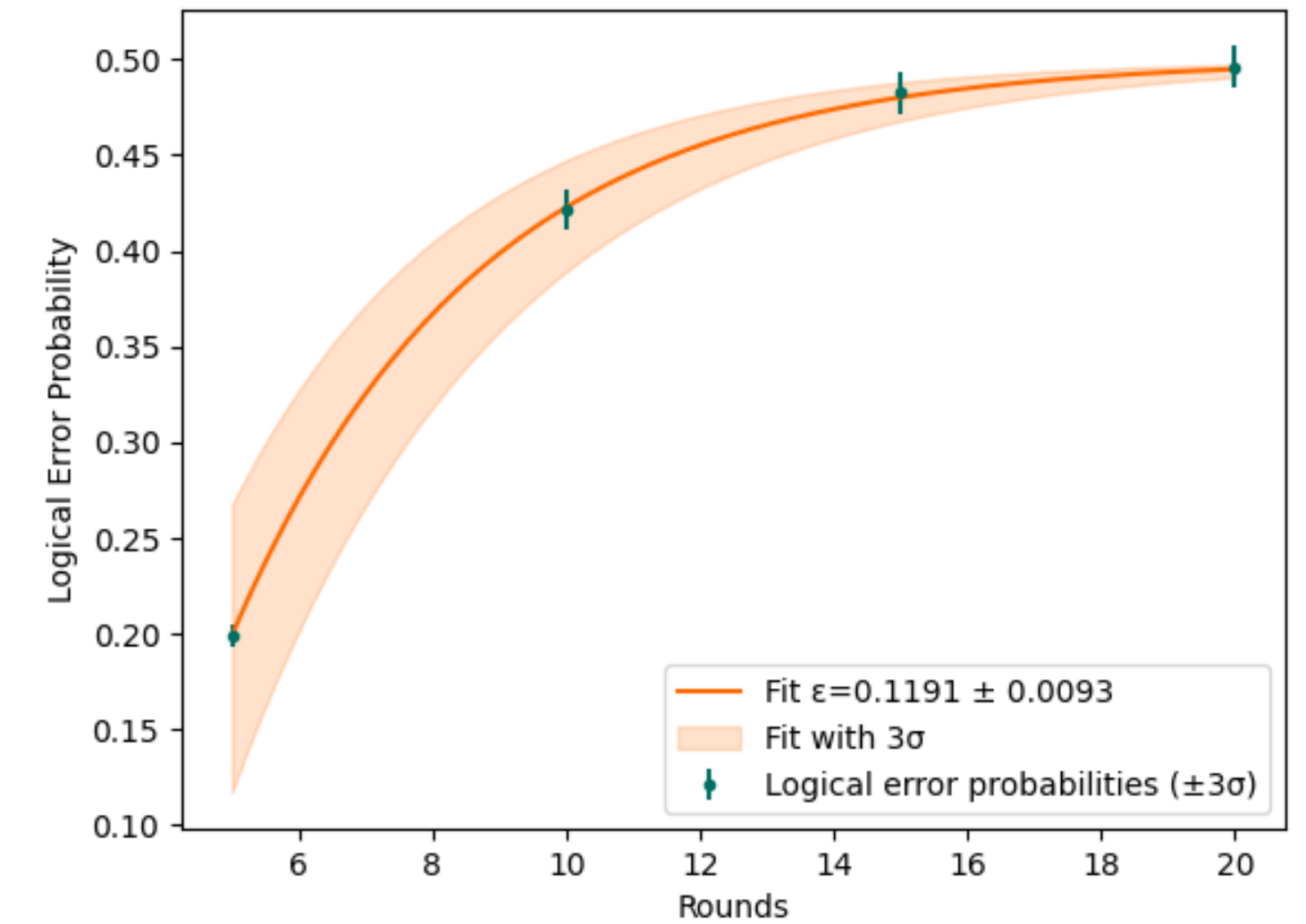
Defect rate



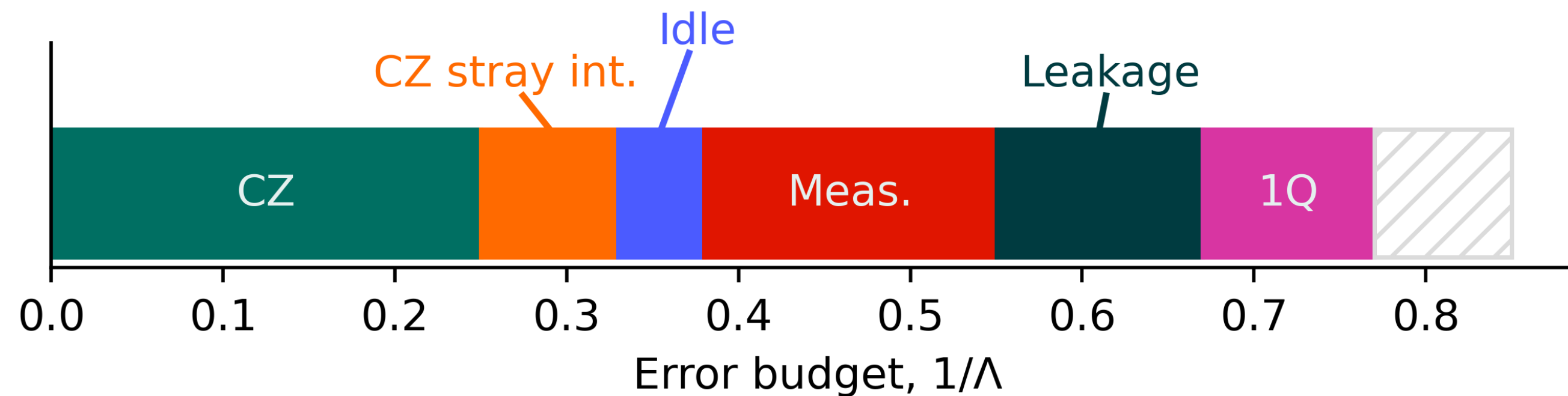
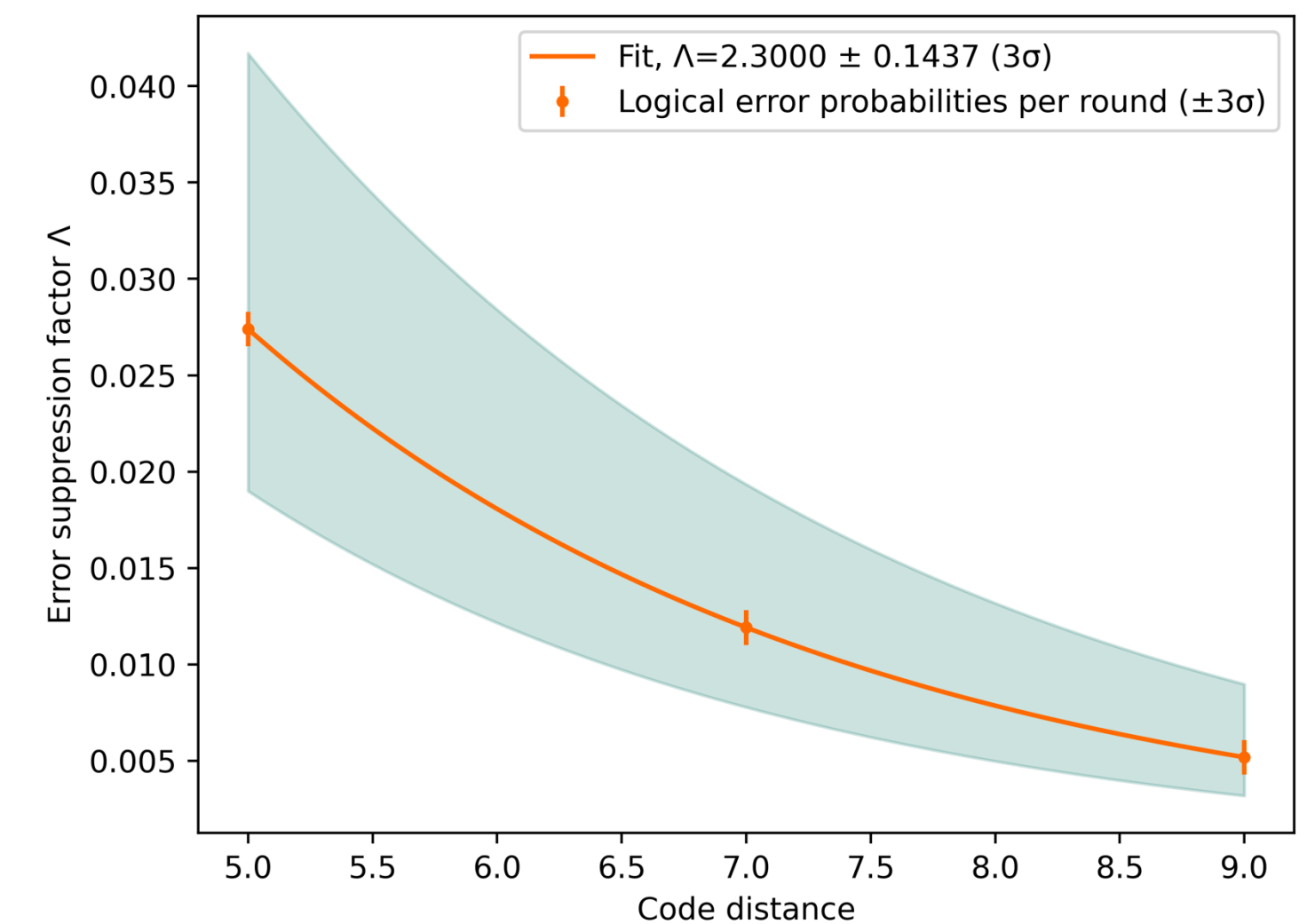
Detector correlation matrix



Logical error probability (LEP) per round: ϵ



Error suppression factor: Λ



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