Quantum Delta
the Netherlands

Quantum Computing & Simulation (CAT-1)

Where do we come from?
Where are we going?

Quantum Delta NL

Projectvoorstel voor het
Nationaal Groeifonds

Quantum Delta NL Information meeting
20 May 2021

Lieven Vandersypen
QuTech

Quantum Infinity

2015 DiCarlo and Bertels team up to develop a full stack system based on superconducting qubits

Motivation: learn from system integration

2017 Two superconducting qubits integrated in a full stack. Live demo at the annual meeting of the QuTech-Intel collaboration

2018 decision to merge Quantum Infinity and Quantum Inspire efforts

Quantum Inspire

Started 2017, focus on

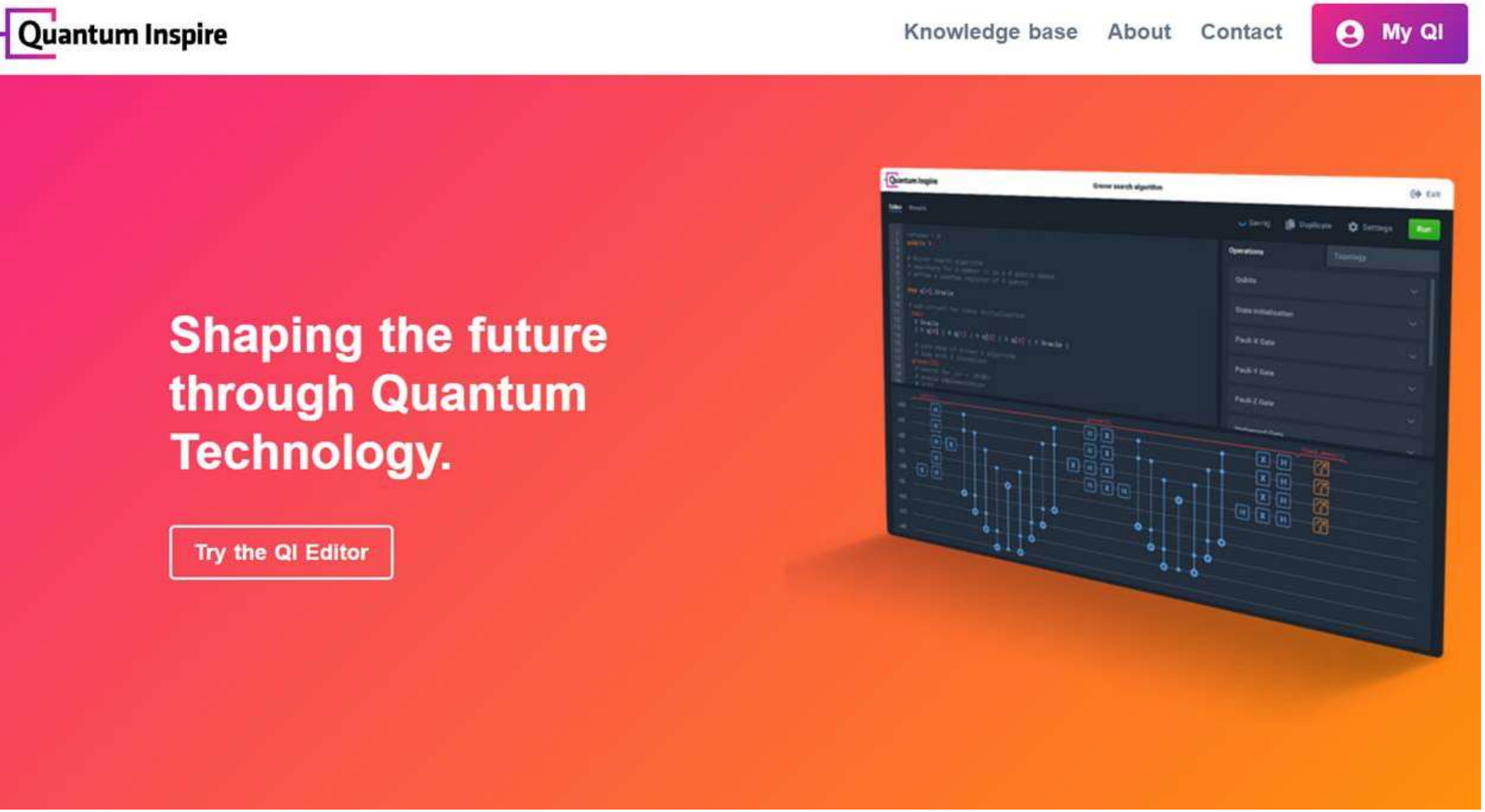
1) simulated qubits in collaboration with SURFsara (TNO, Bertels)
2) full stack system based on silicon qubits (driven by TNO team, building on Vandersypen group expertise)

Motivations:

1) learn from system integration
2) offer a public platform for education
3) offer a public platform to facilitate application development
4) demonstrate technology leadership, act as seed for local start-ups

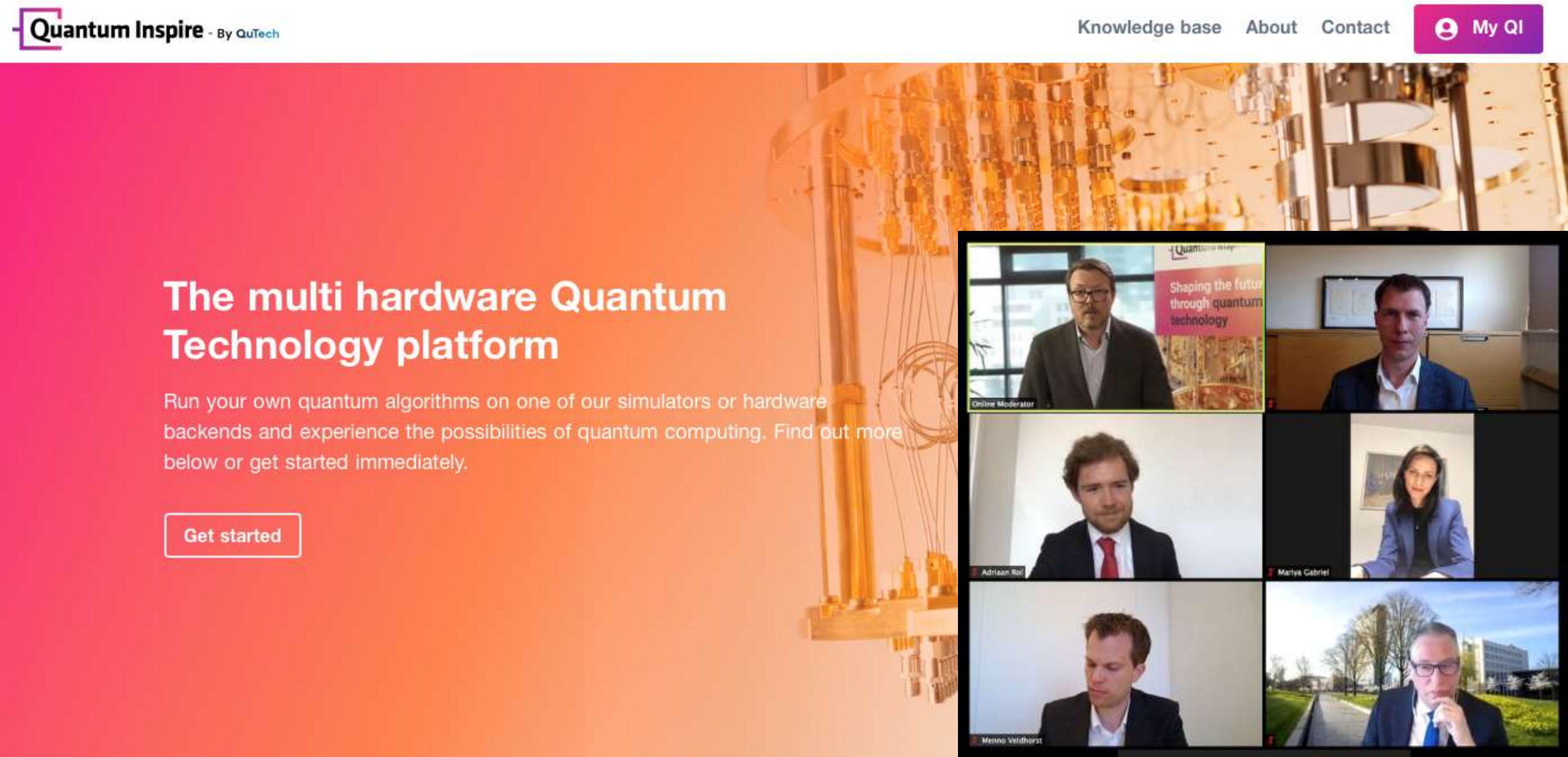
Quantum Inspire publicly launched!

Sept. 4, 2018, offering perfect qubits (classical computer simulation).

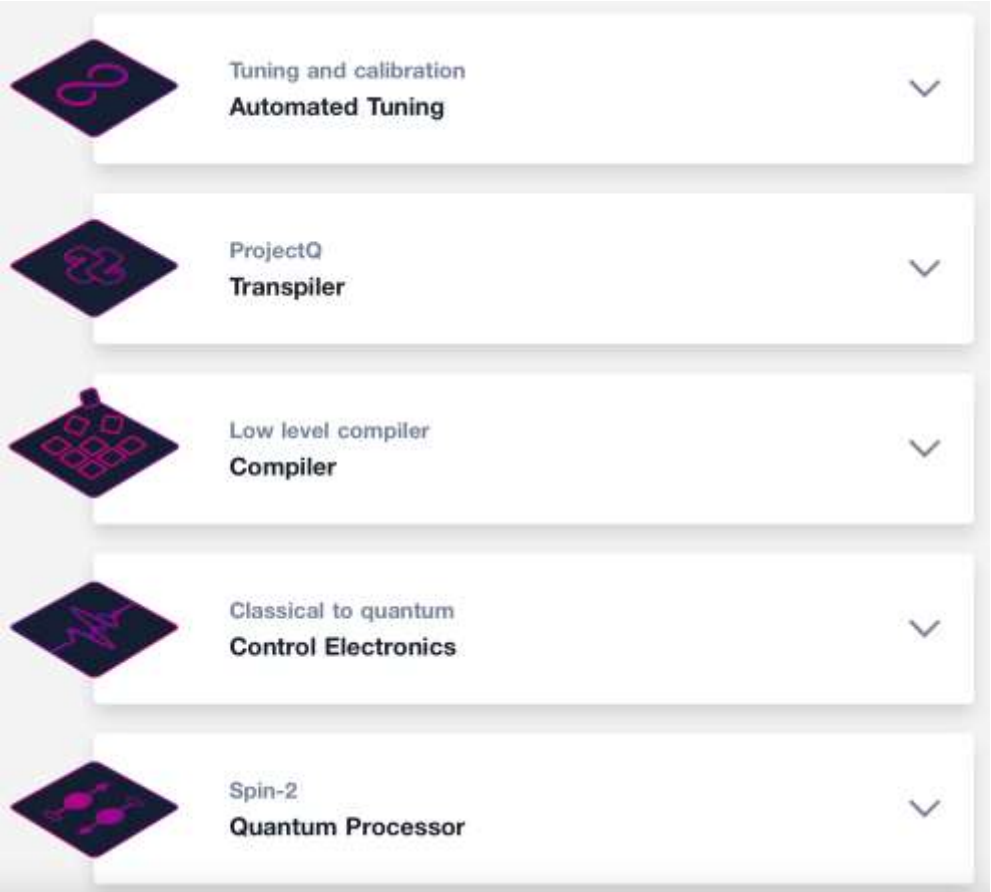


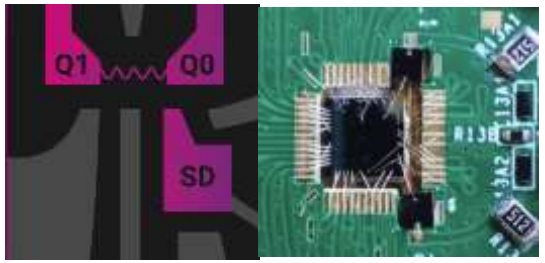
Cartesius: the Dutch supercomputer

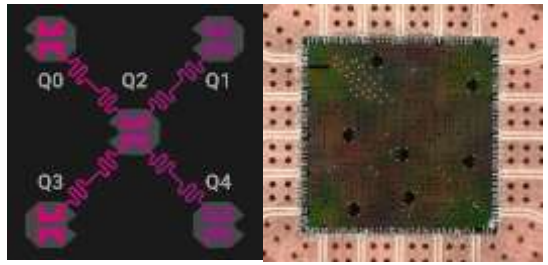
First European quantum computer in the cloud (April 2020)

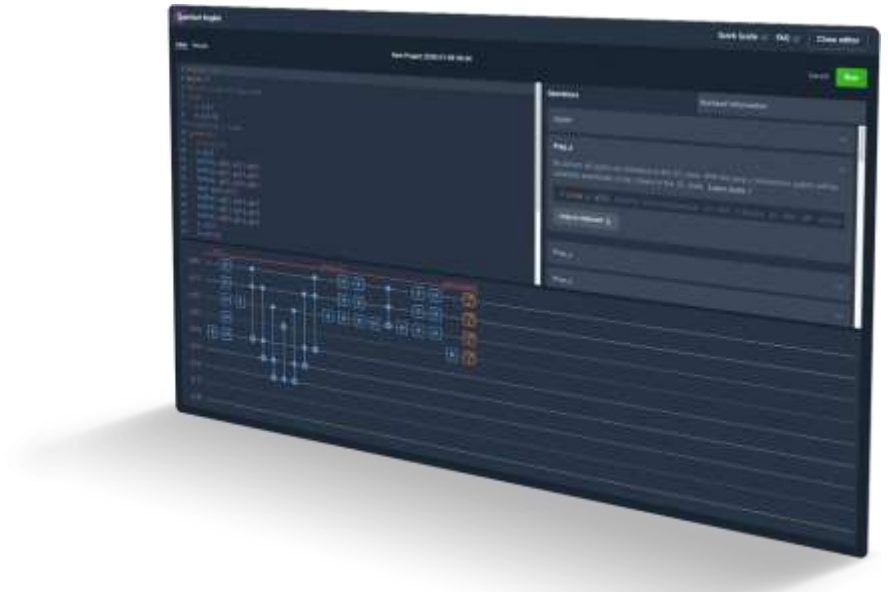


- First European platform offering access to real qubits
- First platform to offer two different qubit types
- First platform to offer silicon spin qubits
- First public (non-commercial) platform









circuit model

Example application development

- Quantum Phase Estimation algorithm for H_2 (2 qubits + 1 ancilla), and H_4 (9 qubits) tested on a realistic error model for superconducting qubits (2017)
- First calculation of polarizability on a quantum computer (2019)

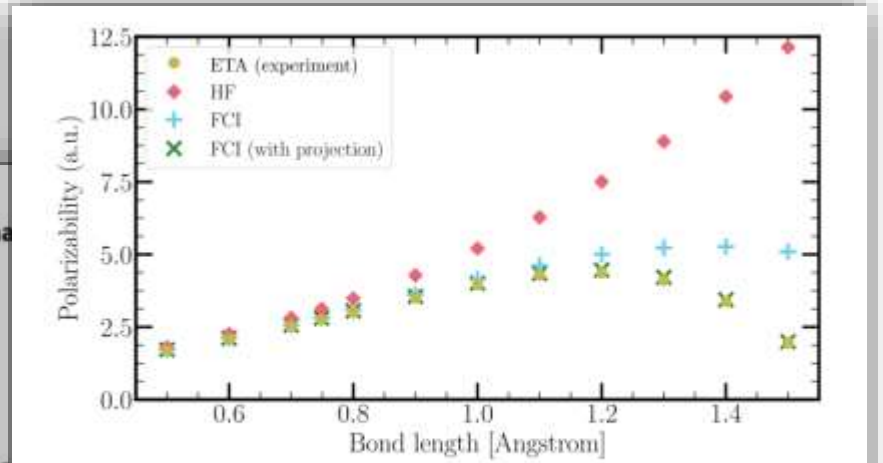


Fig. 4 Estimated polarizability of the hydrogen molecule as a function of the bond distance, in atomic units (1 a.u. = 0.14818471 Å^3).

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Calculating energy derivatives for quantum chemistry c
quantum computer

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Quantum Inspire – a cornerstone of the growth fund proposal

Demonstrated leadership position, credibility

Motivations remain compelling:

1) *(learn from system integration)*
2) *offer a public platform for education*
3) *offer a public platform to facilitate application development*
4) *demonstrate technology leadership, act as seed for local start-ups*

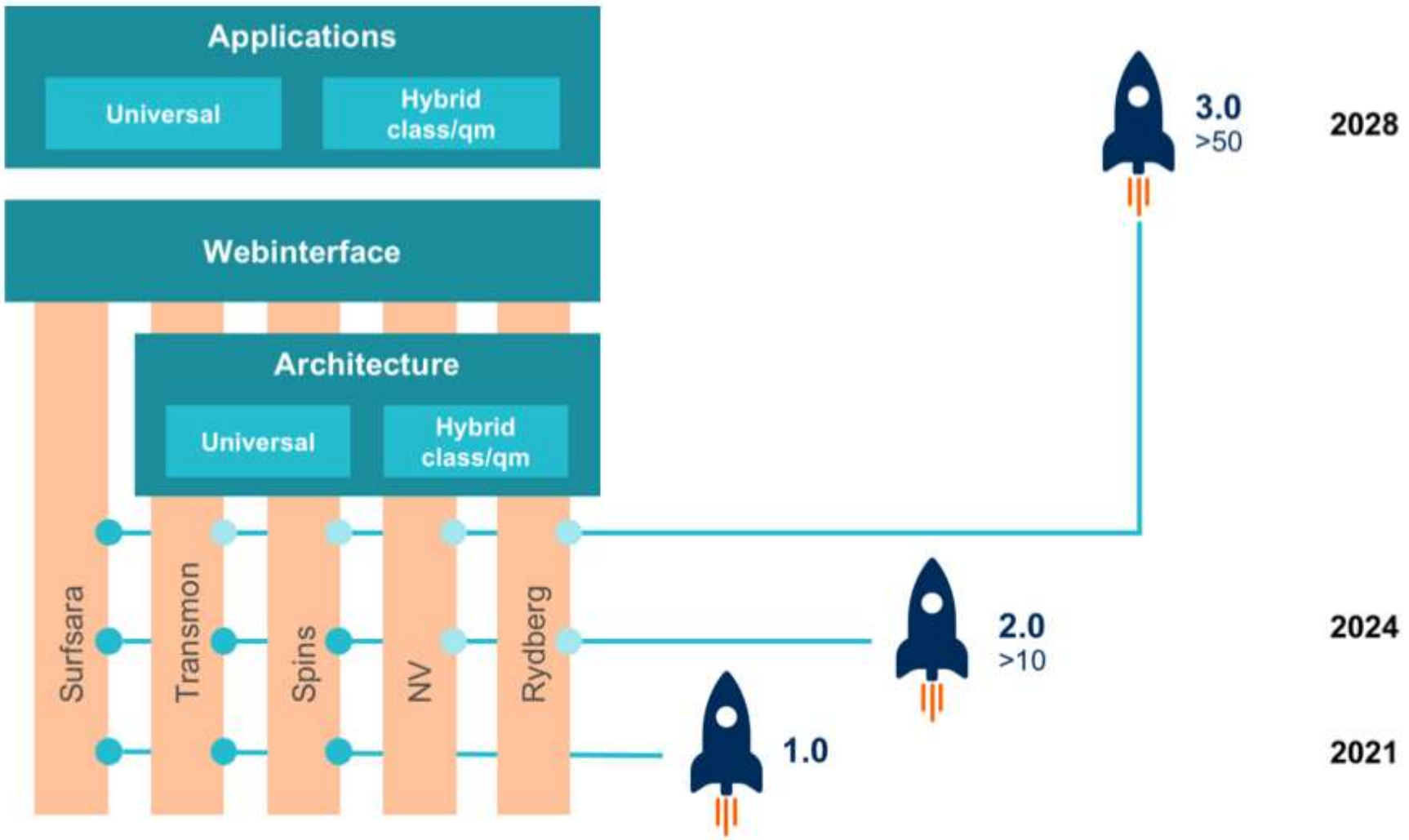
Flying start through the Startimpulse funding

The quantum growth fund – an opportunity and responsibility to make a difference

- What we did propose: a rather focussed, targeted effort to deliver on the promise behind these motivations.

- What we did not propose: fund 50 groups who get one postdoc each

KAT1 in a nutshell

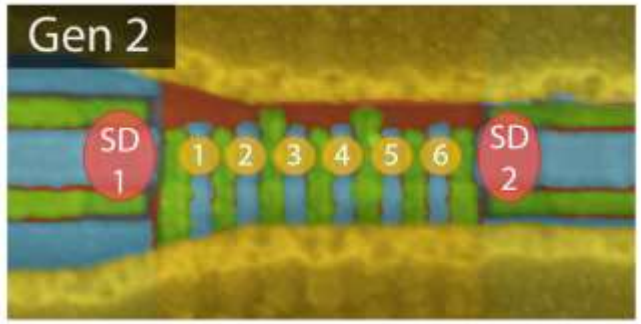


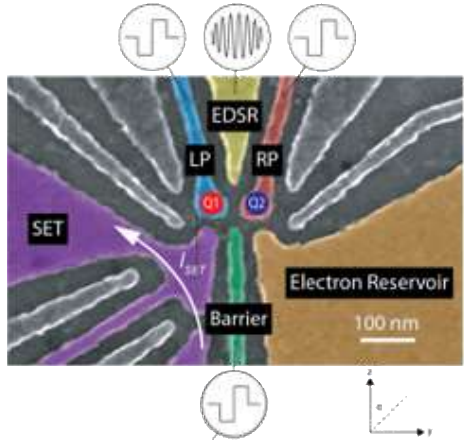
From the proposal:

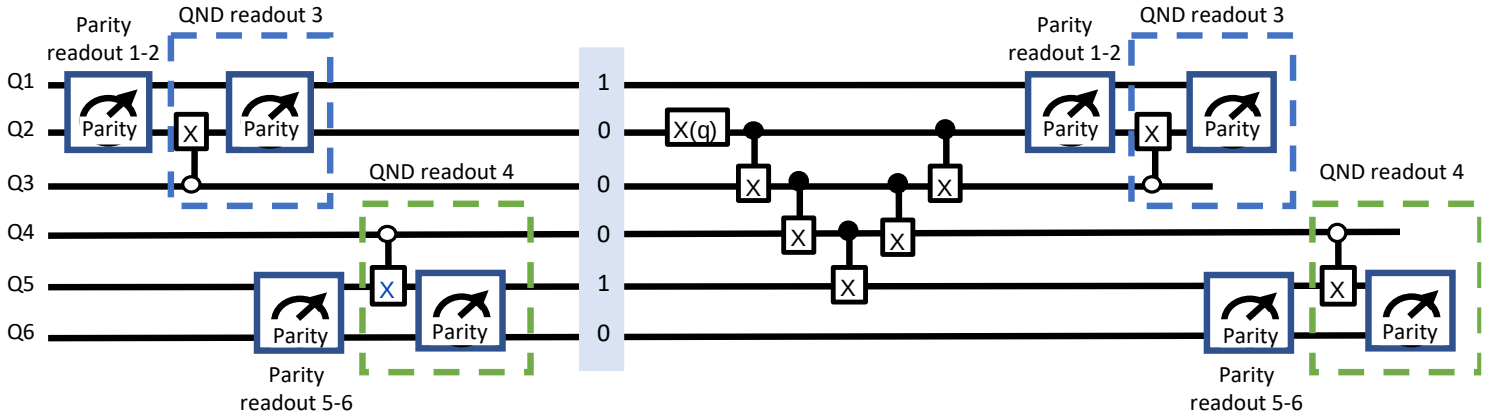
Aims
- achieve quantum advantage
- engage end-users for application development
- engage SMEs
- feed/engage Dutch quantum industry
- education and training

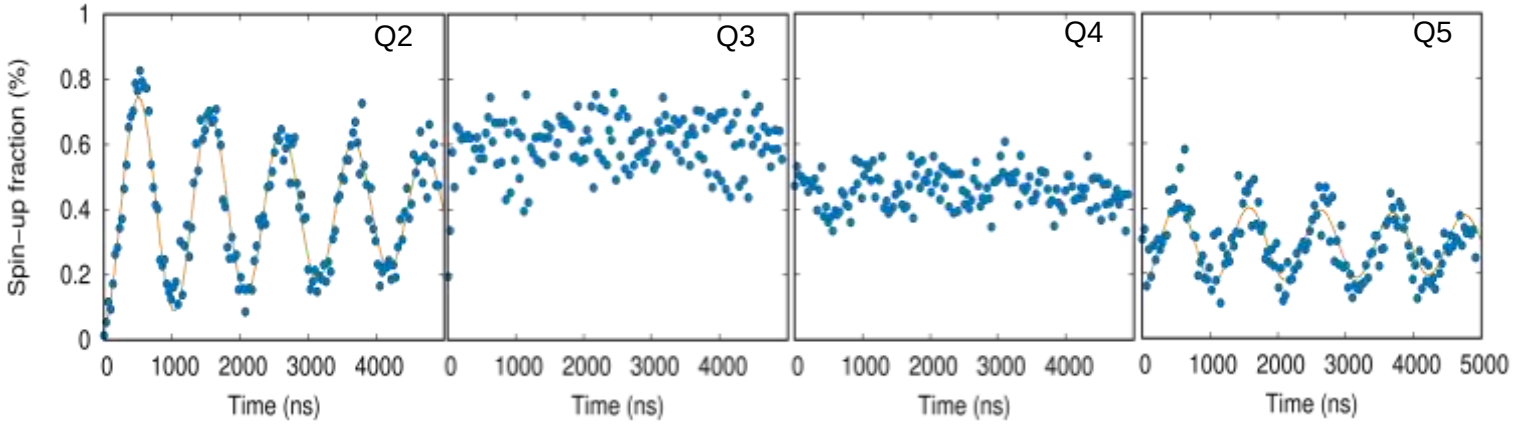
Approach:
- hardware agnostic at the top
- at least 3 Dutch qubit types + emulator
- modular structure
- application hubs, field labs
- open source

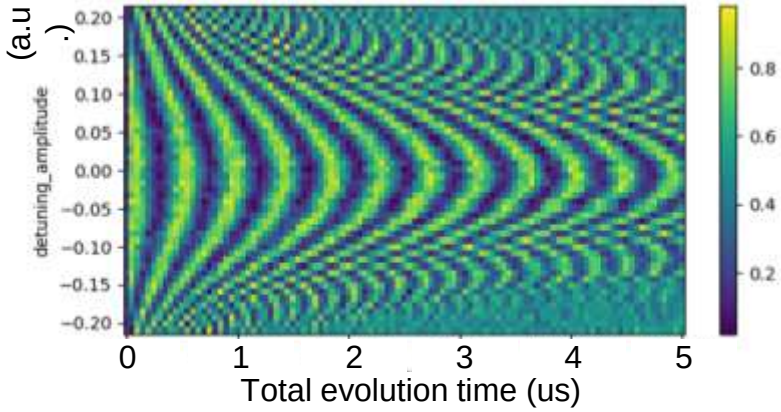
Moving along - spin qubit example











99.5% two-qubit gate fidelity

Links with other parts of the growth fund

- AL1 to bring in new concepts
- AL2 to support IP, start-ups, SMEs
- AL3 to support education, talent pool
- AL4 to support society readiness
- NanoLabNL for access to worldclass nanofabrication facilities
- House of Quantum as showcase of Quantum Inspire