KEYNOTE

Forum TERATEC 23
Unlock the future

Tangible Quantum Computing Benefits, now amplify Quantum production performance

Animée par Georges-Olivier REYMOND
12h35 - 12h50

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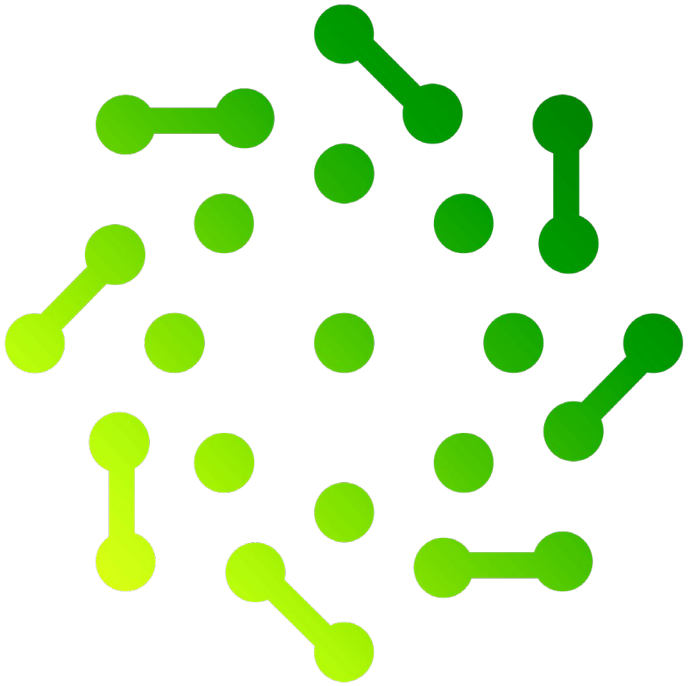
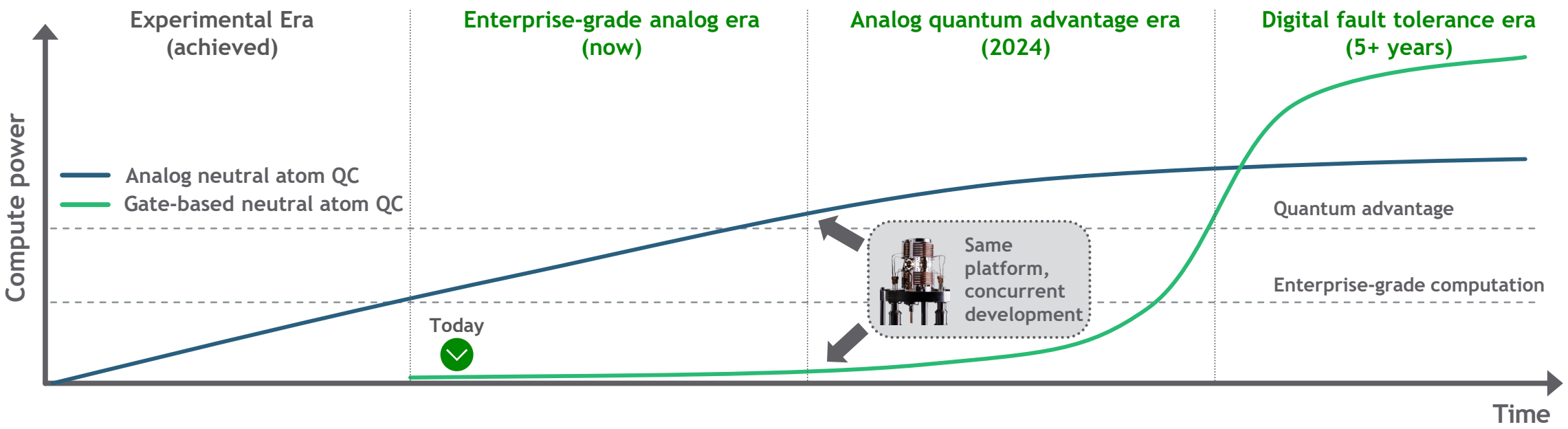


PASQAL

Tangible quantum computing benefits—now

Teratec | 31 May 2023

Concurrent tech development stems from unique neutral atom approach



Near-term advantages

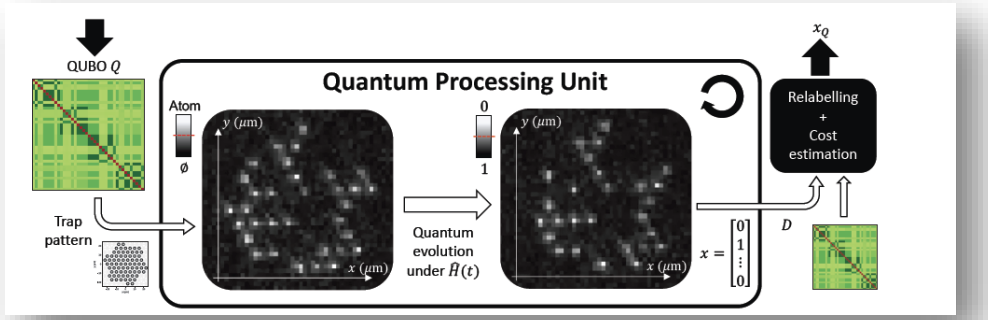
- Inherently pristine qubit
- Field programmability
- Multiple analog computing modes

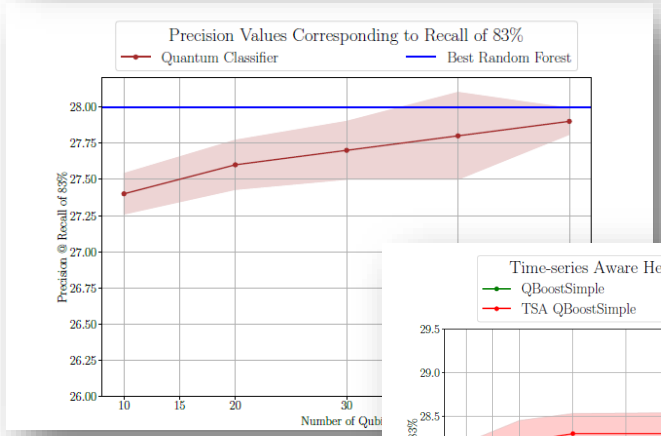
Fault tolerance advantages

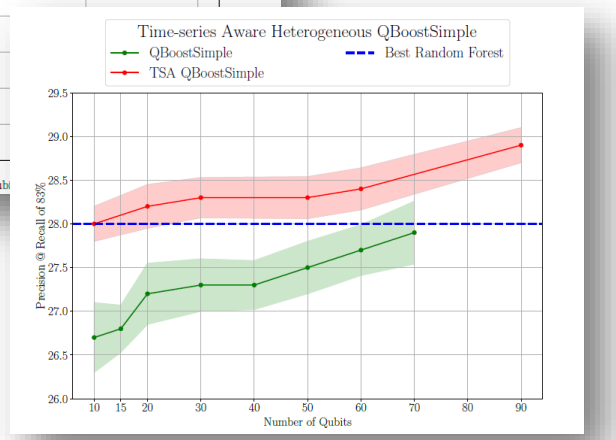
- Scalability
- Long qubit coherence
- One-to-many qubit connectivity

Room temperature

Method & results | Quantum optimization for predicting credit risk







Method

- **QBoost**-based hybrid quantum-classical algorithm trained on PASQAL's 50-qubit quantum processing unit
- Constructed a **strong binary classifier** via **Quadratic Unconstrained Binary Optimization** of the weak Decision Tree classifier ensemble
- **Random Graph Sampling**: a proprietary algorithm to speed up neutral atom QC by randomly sampling partial solutions, then reconstructing together for the complete solution
- Distinct advantages of the quantum approach over the classical approach from the **imbalanced dataset & expansive solution space**

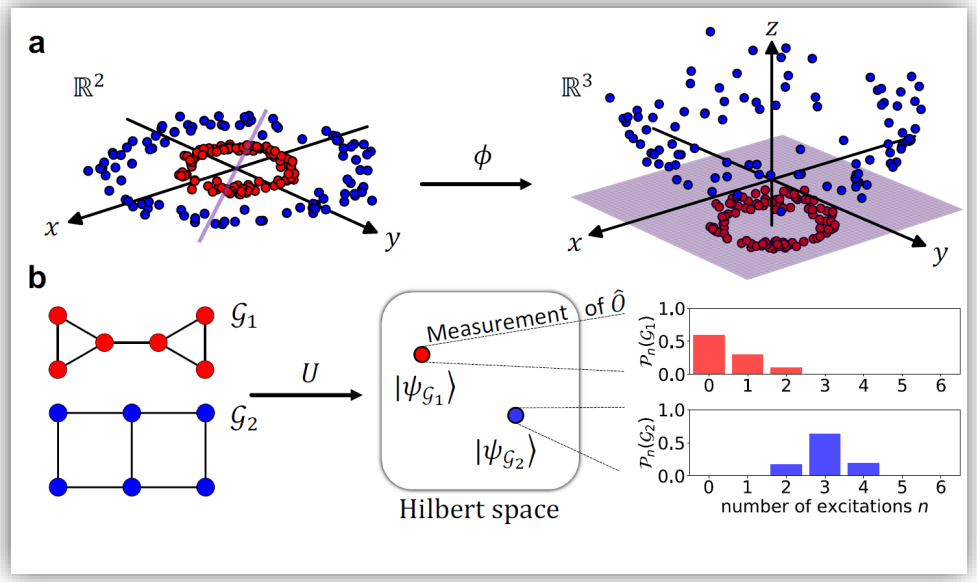
Results

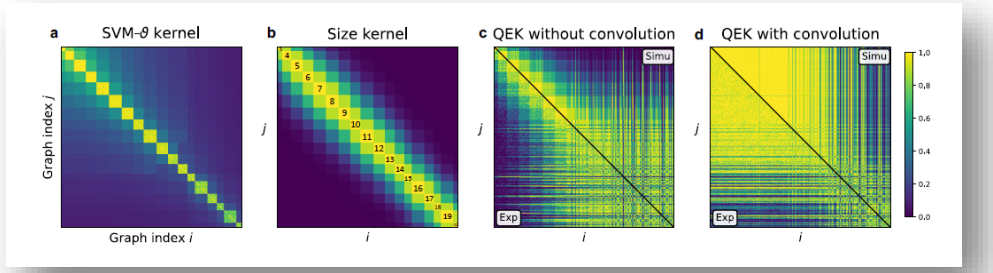
96%
fewer initial learners

Quantum approach achieved the same level of precision and recall value as classical solution while using **a much simpler model**

- **Concrete advantage over classical benchmark** shown from simulation w/ additional flavor of qubit interaction on ~90 qubits (on roadmap by 2024)
- **First-of-their-kind results** pave the way for quantum machine learning solutions for similar problems across the financial sector

Method & results | Quantum Evolution Kernel application to large biochemistry datasets





Method

- Implemented **Quantum Evolution Kernel** (QEK), a novel quantum machine learning algorithm
- **Binary classification task** on a biochemistry dataset – Predictive Toxicity Challenge on Female Mice
- Used a **neutral-atom QPU** made of ^{87}Rb atoms trapped in arrays of optical tweezers to construct a feature map resulting from the dynamics of the quantum system

Results

1000x
speed-up vs. other quantum impl.

QEK captures **features that are invisible to classical kernels** and provides **significant speed-up** over competing quantum implementations

- Real **QPU performance** matches closely with simulation of **perfect, noiseless** QPU, showing resilience to noise
- Benchmarked against classical methods such as Graphlet Sampling, Random Walk, Shortest Path, and SVM-Theta kernels
- QEK performance **on-par with best classical kernel** on real data. *Preliminary result: 14-32% improvement over **classical kernels** on artificially relabeled[1] data; further study underway*

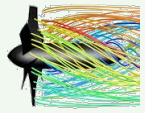
1. Relabeled data maximizes the utility of the rich quantum feature space.

We have a full-stack offering and a world-class team ready to partner with you today

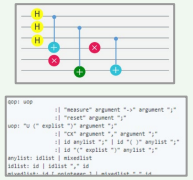
PASQAL **Our full-stack Quantum Computing solution for you**

Software & applications

Turn-key solutions



Coding environment



Middleware

HW-accelerated quantum libraries

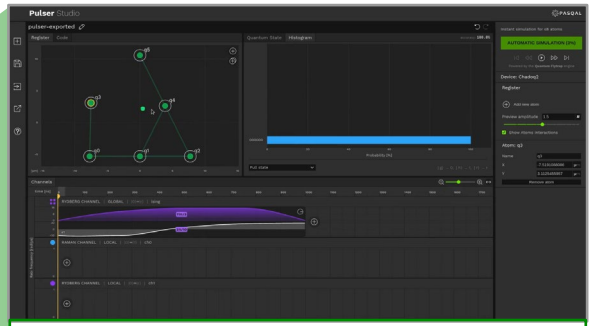
- Machine Learning
- Optimization
- Differential Equations
- Simulation

Hardware

Quantum HW

- Quantum Registers
- Electronics
- Laser Control
- Room temp. ultra-high vacuum

Our customers & end-users



(Example offering) Pulser studio:
No-code approach to allow engineers and scientists to learn about **quantum algorithms** on neutral atoms and explore their potential

Quantum Processor:
Optical tweezers to control neutral atoms and engineer full-stack processors with high connectivity and scalability