Efficient QUantum
ALgorithms for IndusTrY

⟨EQUALITY⟩

Join our community!

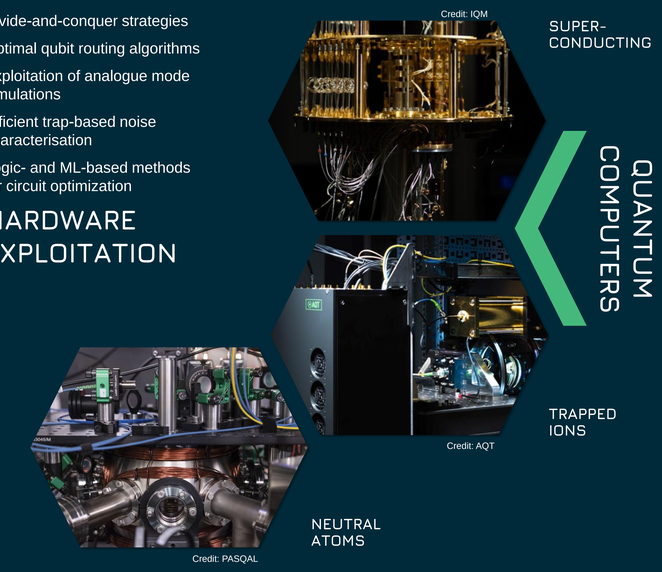
- **EQUALITY** brings together leading research groups, SMEs, and prominent industrial players to develop cutting-edge quantum computer algorithms to solve strategic industrial problems running on real quantum hardware.
- These are complex problems with enormous computational requirements, forcing engineers either to use simplistic models or to rely on expensive build-and-test cycles.

CORE ALGORITHMS

- Differential and Stochastic differential equation solvers
- Quantum generative models
- Quantum chemistry simulators
- Simulators for periodic materials
- Quantum evolution kernel methods
- Non-kernel quantum ML techniques
- Gibbs state-based optimization

HARDWARE EXPLOITATION

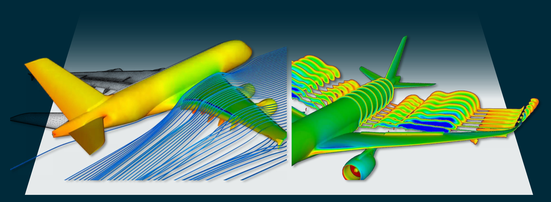
- Divide-and-conquer strategies
- Optimal qubit routing algorithms
- Exploitation of analogue mode simulations
- Efficient trap-based noise characterisation
- Logic- and ML-based methods for circuit optimization



- Quantum computers provide an opportunity to tackle such questions, giving Europe a competitive edge and unlocking billions of euros in value for those industries over the coming decades.
- The consortium was awarded in the highly competitive Horizon Europe programme. The partners will receive a cumulative €6M grant from the European Commission from 2022 to 2025.

AERODYNAMICS SIMULATION AND OPTIMISATION

- New energy storage technologies, such as better batteries and fuel cells, are crucial to the green transition.
- Simulating these processes, consume huge computational resources, often beyond the capabilities of classical computers. Quantum computers offer a path forward for overcoming current trade-offs between precision and scale.
- **EQUALITY** investigates quantum algorithms to optimize the modelling of batteries and fuel cells, providing a multiscale picture of their dynamics.



Visualization of aerodynamics simulation. Credit: Airbus

ENERGY STORAGE MATERIALS AND DESIGN

- More energy-efficient airplanes are one of the ways to propel the aviation industry towards lower emissions.
- Doing so involves detailed simulations of the air flow around the aircraft and the aerodynamic forces on its surfaces, while optimising for frame weight, integrity, and performance, which requires enormous computational resources.
- **EQUALITY** investigates how quantum computers could speed up the development and optimisation of critical aerospace problems.

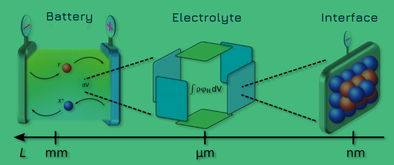
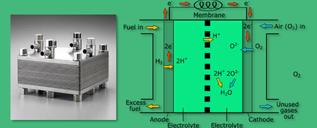


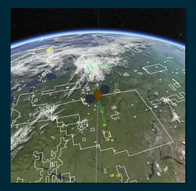
Illustration of the multi-scale approach for the example of a battery.



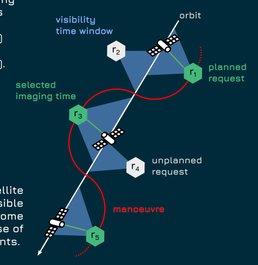
Left: state of the art planar solid-oxide fuel cell (SOFC) stack developed for stationary applications. Right: basic set-up of a FC via the example of a SOFC.

SPACE MISSION OPTIMISATION

- Space systems deliver critical solutions for enterprises and governments, such as telecommunication satellites, Earth observation instruments, deep space missions, etc.
- However, mission optimisation involves solving enormously complex mathematical problems which are extremely hard to tackle using classical computing methods.
- **EQUALITY** investigates quantum optimisation methods for faster and more efficient planning of space missions



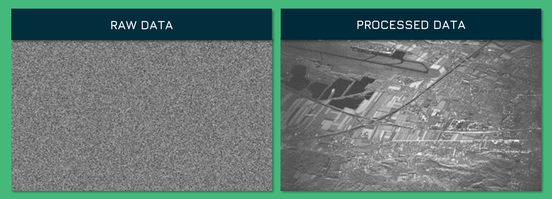
Visualisation of mission plan depicting acquisition requests (white), planned acquisitions (yellow) and acquired observations (green).



Scheme of an Earth observation satellite mission. Each request is accessible during a limited portion of the orbit. Some requests cannot be fulfilled because of manoeuvre time constraints.

SPACE DATA ANALYSIS

- Earth-observation satellites provide information that are essential, for example, to evaluate the impact of climate change.
- Current trends, such as the use of satellite constellations and lower-cost imagery datasets are often subject to missing reference data, irregular sampling, and pseudo-periodic phenomena. As such, they demand more powerful post-processing techniques.
- **EQUALITY** investigates quantum machine learning techniques to alleviate the computational bottlenecks in space data analysis.



Space data processing: Synthetic-Aperture Radar (SAR)

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