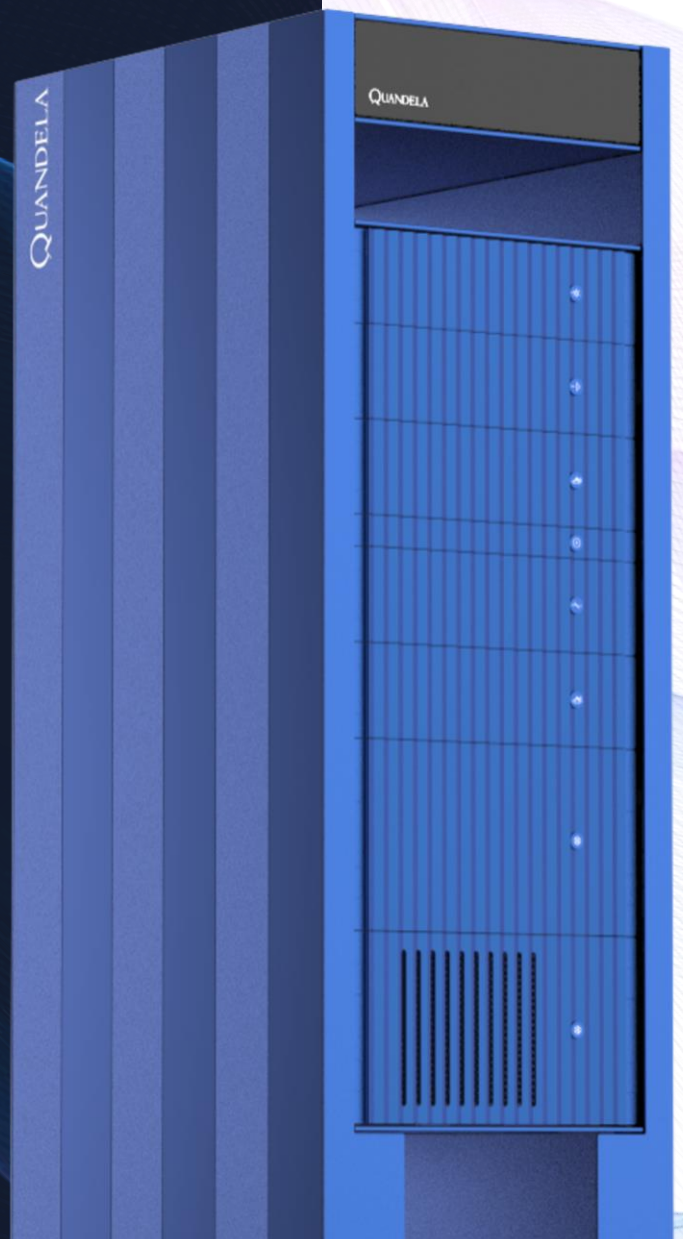
QUANDELA

Quantum Toolbox

easy-to-use cutting-edge quantum algorithms to unlock tens of use-cases



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Quandela offerings

Quantum Transformation

Defense
Energy
Finance
Travel & Transport

Pharma
Automotive
Discrete Manuf.
Chemicals

QUANDELA TRANSFORMATION

QUANTUM ACCELERATION PROGRAM

20+ Incubation ecosystems favorable to Quantum

QUANDELA HUBS

PARTNER ECOSYSTEM INCUBATION

Academics
Professional Upskilling
Developers

QUANDELA CLOUD

CLOUD SERVICES

Data centers
HPC centers
Research centers
Labs

QUANDELA HARDWARE

MOSAIQ
EDLIGHT
PROMETHEUS

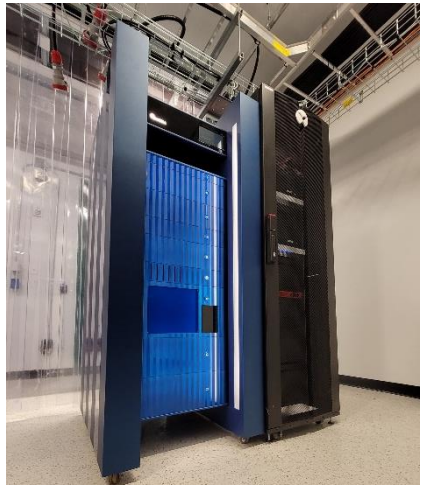
Datacenter-ready QC systems: a proven track record

MOSAIQ – 6 Qubits

Delivery time 8 months.

Quantum Operations: 144

MOSAIQ – 12 Qubits



Delivery time 12 months.

Quantum Operations: 576

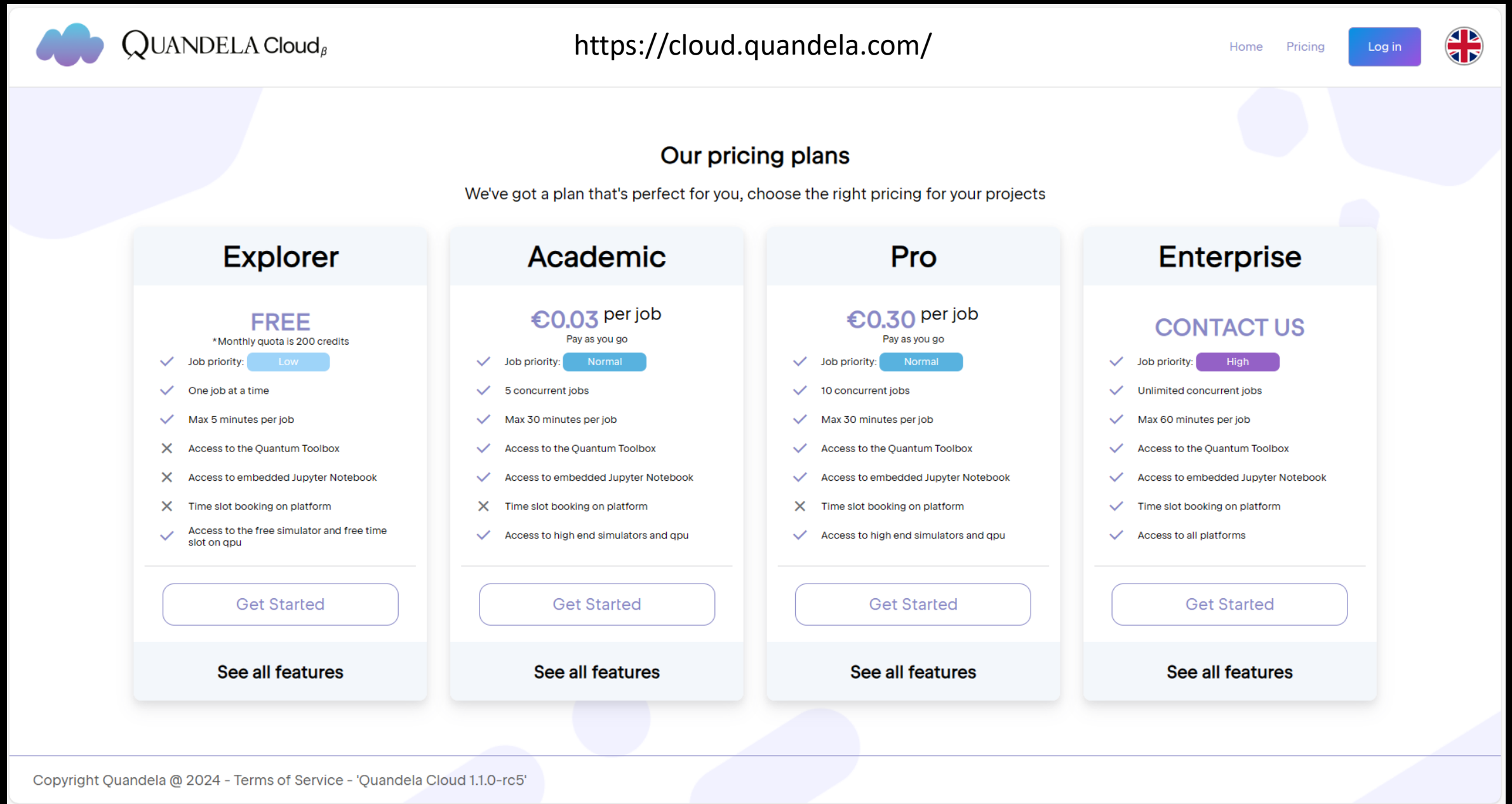
MOSAIQ – 24 Qubits

Under development in Quandela's factory

Quantum Operations: 2328

- Clients: OVHcloud, exaion EDF GROUP
- 8 to 14 months delivery
  3 days deployment
- Low Energy Consumption
  (from 2.3kW-5kW)
- Seamless integration into datacenter workflow via REST API, SDKs, scheduling and programming framework
- High stability: NOT sensitive to vibration, temperature, EM radiations
- Fully upgradable, modular, customizable
- Qubits: full connectivity
- Fidelity: 1-qubit: 99,94% 2-qubit: 98,2% 3-qubits: 86%

Quantum computing cloud offering



Quantum Acceleration Program

Quantum Transformation

Discover

Understand the principles of quantum computing and photonics, assess what part of your business will be disrupted.

ASSETS

- Orientation
- Exploration

Design

Identify use-cases, assess the feasible ones and develop a proof-of-concept for the most promising option. Start scalability study.

ASSETS

- Proof of Concept
- Scaling up to Pilot

Deliver

Validate scalability assumptions with experiments. Integrate solution in production environment.

ASSETS

- Integration into client processes

Accelerate

Towards quantum emancipation. Clients will be able to tackle their quantum computing use-cases.

ASSETS

- Centre of excellence

Quantum Toolbox going live
5 easy to use algorithms

Toolbox

VQE chemistry	VQE custom	CVaR-VQE	Graph isomorphism	Dense Subgraph identification
Compute **ground state** of BeH, LiH, H2O, H2 on **QPU**	Compute ground state of **user-chosen Hamiltonian**	VQE variant to solve **combinatorial optimisation problem**	**Boson sampling** based algorithm to **check whether two graphs are isomorphic**	**Boson sampling** based algorithm to **identify dense subgraphs**

Quantum Toolbox going live

5 easy to use algorithms to unlock tens of use-cases

Toolbox

VQE chemistry	VQE custom ($H = \sum h_\alpha P_\alpha$)	CVaR-VQE	Graph isomorphism	Dense Subgraph identification
Compute **ground state** of BeH2, LiH, H2O, H2 on **QPU**	Compute ground state of **user-chosen Hamiltonian**	VQE variant to solve **combinatorial optimisation problem**	**Boson sampling based** algorithm to **check whether two graphs are isomorphic**	**Boson sampling** based algorithm to **identify dense subgraphs**

Use-cases

Battery design : - Compute **force field on molecules** - Compute **binding energies**	Try to compute **new molecules ground states** on a photonic QPU Solve **differential equation** using energetic formulation	**Multi-agent path finding:** For logistics issues in warehouses **Train-unit assignment problem:** to minimize number of carriages	**Fault detection in chip design :** defect-free chip should be isomorphic to graph of perfect chip **Cross-checking databases in cheminformatics**	**Drug design :** Docking problem i.e. finding optimal configuration for ligand-receptor couple

Five toolboxes unlocking tens of use cases

Ground state energies of larger molecules

Toolbox

VQE chemistry

Compute **ground state** of BeH2, LiH, H2O, H2 on **QPU**

Use case

Problem : Computing ground state of large molecules becomes quickly infeasible

Solution : Active space method such as **DMET-VQE** enables to separate a molecule in fragments and compute its ground state energy

Benefits : it will enable **more accurate and faster predictions** of ground state energies of molecules, which in turn enables to compute force field, binding energies **for material design**

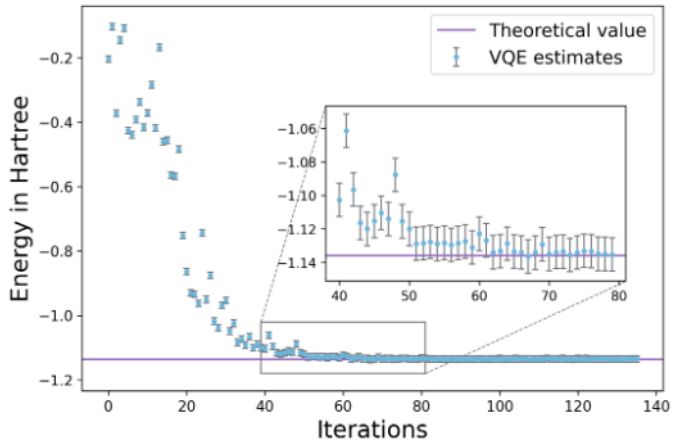


Fig. Energy vs iterations for H2 molecules with given bond length

Five toolboxes unlocking tens of use cases

Predicting behaviour of mechanical structure (dams, nuclear pipes)

Toolbox

$H = \sum h_\alpha P_\alpha$ VQE custom

Compute ground state of **user-chosen Hamiltonian**

Use case

Problem : solving PDEs **represents >50% of HPC usage of EDF**, crucial for mechanical structure, electricity bill is consequential

Solution : EDF and Quandela co-developed a variational algorithm based on an energetic formulation

Benefits : quantum algorithm scales better (poly-logarithmic) than classical state-of-the-art. It will **reduce energy consumption** when solving PDEs.

Five toolboxes unlocking tens of use cases

Directing multiple robots in a warehouse without collisions

Toolbox

CVaR-VQE

VQE variant to solve **combinatorial optimisation problem**

Use case

Problem : multi-agent path finding notorious **NP-hard problem**. Useful in **logistics**, drones traffic management, etc. Only heuristics to solve it and limited to few agents on medium-size graphs.

Solution : Quandela co-developed with a client the energetic formulation of that problem to solve it using CVaR-VQE.

Benefits : as QPU size grows, this algorithm should be able to tackle instances where **number of agents, locations and constraints are greater** compared to **classical solvers**

Five toolboxes unlocking tens of use cases

Assigning minimal amount of train units to trips

Toolbox

CVaR-VQE

VQE variant to solve **combinatorial optimisation problem**

Use case

Problem : train-unit assignment problem is a notorious **NP-hard problem**. Useful in rolling stock circulation phase. Crucial economically to minimize the number of train-units used as one train-unit costs millions of euros.

Solution : Quandela co-developed with a partner the energetic formulation of that problem to solve it using CVaR-VQE.

Benefits : solving large instances in short time of TUAP is beyond the reach of classical devices. This approach provides a **quantum heuristics sample-efficient and resilient to noise**.

Five toolboxes unlocking tens of use cases
Cross-checking chemical description

Toolbox

Graph isomorphism

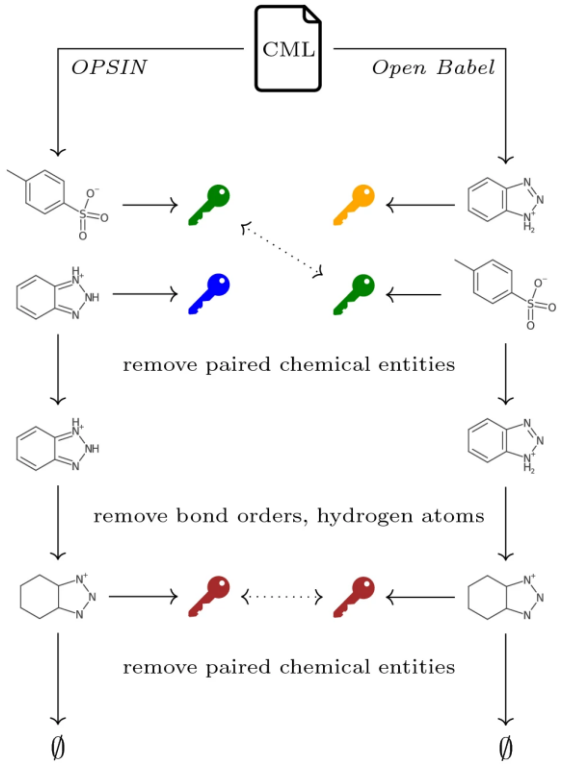
Boson sampling based algorithm to **check whether two graphs are isomorphic**

Illustrative Use case

Problem : various machine-readable entries for chemical molecules . How to compare those since different basis of representation were used ?

Solution : represent each **machine-readable entry with keys**, then we compare keys, if they **don't correspond make simplification** on original data to see **if keys now match**. If so, we detect **differences in notations** or retrieve **chemical experimental information** about a dataset.

Benefits : graph isomorphism problem is a really hard problem (NP), with no efficient classical solution. Some heuristics are fast but not exact. Our proposed approach provides a **quantum heuristics exploiting hardness of boson sampling that should provide a speed-up when scaling up.**



Ref : Merkys, A., Vaitkus, A., Grybauskas, A. *et al.* Graph isomorphism-based algorithm for cross-checking chemical and crystallographic descriptions. *J Cheminform* **15**, 25 (2023). https://doi.org/10.1186/s13321-023-00692-1

Five toolboxes unlocking tens of use cases

Molecular docking

Toolbox

Dense Subgraph identification

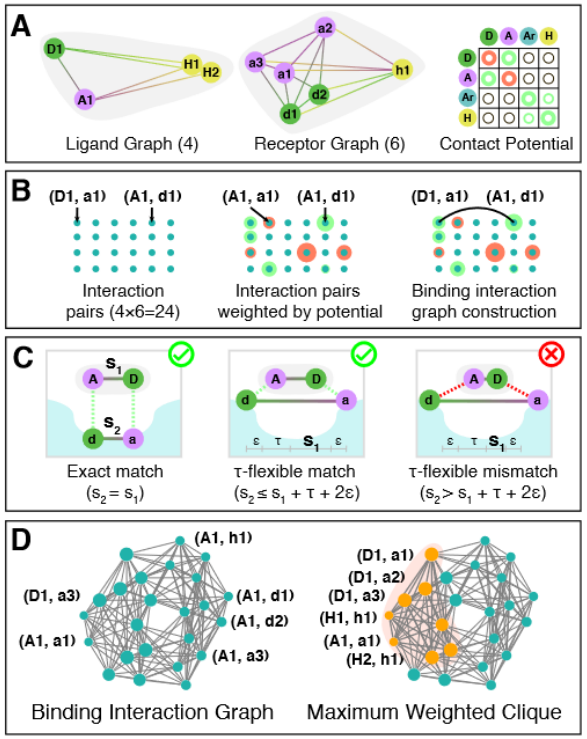
Boson sampling based algorithm to **identify dense subgraphs**

Illustrative use case

Problem : Molecular docking is **central in structural molecular biology and computer-assisted drug design**. The goal is to predict **how a ligand** (small molecule) **will dock to a protein** (large molecule). There is a vast number of ways to do so, which makes is a **hard problem for classical computers.**

Solution : map the ways a ligand docks to a protein (step A on the right panel) to a graph called a binding interaction graph (step D on the right panel). Then using Quandela quantum computer one can find the maximum weighted clique, i.e. the optimal solution for a ligand to dock with a protein.

Benefits : molecular docking has no efficient classical solution. Our proposed approach provides a **quantum heuristics exploiting hardness of boson sampling that should provide a speed-up when scaling up.**



•Ref : Leonardo Banchi *et al.*, Molecular docking with Gaussian Boson Sampling.*Sci. Adv.***6**,eaax1950(2020).DOI:10.1126/sciadv.aax1950

Try it yourself!

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https://cloud.quandela.com/webide/command

Or visit us at our booth for a live demo.

Contact me on Linkedin or by email

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