



National Hybrid Quantum Computing Platform

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Quantum Computing, a promising technology, a **new way of thinking**

A **new Paradigm** bridging together **hardware and software** to **accelerate and solve** large-scale **scientific applications** and **real business use-cases**

A **breakthrough** for **unsolvable issue** on classical supercomputers

A **reality** with quantum technologies already available

- Different TRL, Small scale, Still in labs for many of them
- No unique technology to answer all problems, no standardized software layer; no easy access for users

A rich European quantum ecosystem

Diversity of hardware technologies (superc., cold atoms, trapped ions, photonics, cats qubits, etc.)

Software startups investing in verticals (health, CFD, etc.)

An emulator widely deployed, by a European HPC vendor

Strong flagships and consortia supported by Europe, national states and local territories

Industrial end-users ready to engage

Major stake: Support the global community to “Think and Be Quantum driven”

Quantum Computers are not general purpose computers

QC is based on manipulation of natural properties of atomic particles and uses quantum effects

QC cannot be used as classical computers (access, programmability, data, resources management, etc.)

Application/Algorithms **must be re-written** from scratch

QC solves only some **well targeted problems through new algorithms implementation**

A hybrid approach by coupling classical and quantum

QC, **an accelerator** for suitable **HPC/AI** applications and algorithms to be **offloaded to QPU**

A workload approach to be adapted on existing middleware environment

A **well-known access process**

A central place to build a programmability environment, develop and make available scale-out/scale-up quantum computers as applications

A **5 years programme** based on a national physical hybrid HPC/Quantum platform

Strategy from French Quantum Plan (21-01-21)

National funding's 72,3 M€, leverage by European, industrial and regional funding

Also embedded into a European hybrid quantum infrastructure



Objectives



Integrate (HW/SW) quantum technologies in HPC DC

Build the **pilot** of a future HPC/Quantum solution

Assess QC **technologies**

Develop QC **hybrid software stack** (libraries/middleware)

Promote, disseminate and support HQI usage (**applications**)

Programme organization & funding

QPU acquisitions (36,3 M€ (FR) + co-funding by Europe)

Industrial & academic R&D (25,5 M€ + co-funding by industrials)

QC ecosystem and User community support (10,5 M€ (FR) co-funded by Europe, industrials and French regions)



HQI platform, an open and evolutive platform

Complementary QPU technologies

Different Technology Readiness Level

4 acquisition phases: standard product or development partnerships

Analog QPU

Gate-based QPU

Innovative QPU

Scalability of existing QPU systems (Exascale perspective) and acquisition of emergent technologies (LSQ - post-Exascale preparation)

Schedule 2022 – 2026

EuroHPC HPCQS project: the 1st PNCQH phase and the 1st pan-European hybrid HPC/QC platform



<HPC|QS>

**The First
Cloud-based and hybrid
Quantum-HPC
European Infrastructure
2x100 qubits**

GENCI
Le calcul intensif au service de la connaissance



JÜLICH
Forschungszentrum



AtoS



**Quantum
Simulator**

A EuroHPC Research and Innovation action

4 years

12 M€ budget (50% CE, 50% MS)

2,83 M€ (FR – HQI)



Consortium

18 partners, 6 countries

2 quantum nodes (GENCI/CEA – FZJ)

**Create a hardware agnostic,
comprehensive environment made in
Europe for QC and Quantum HPC hybrid
applications**

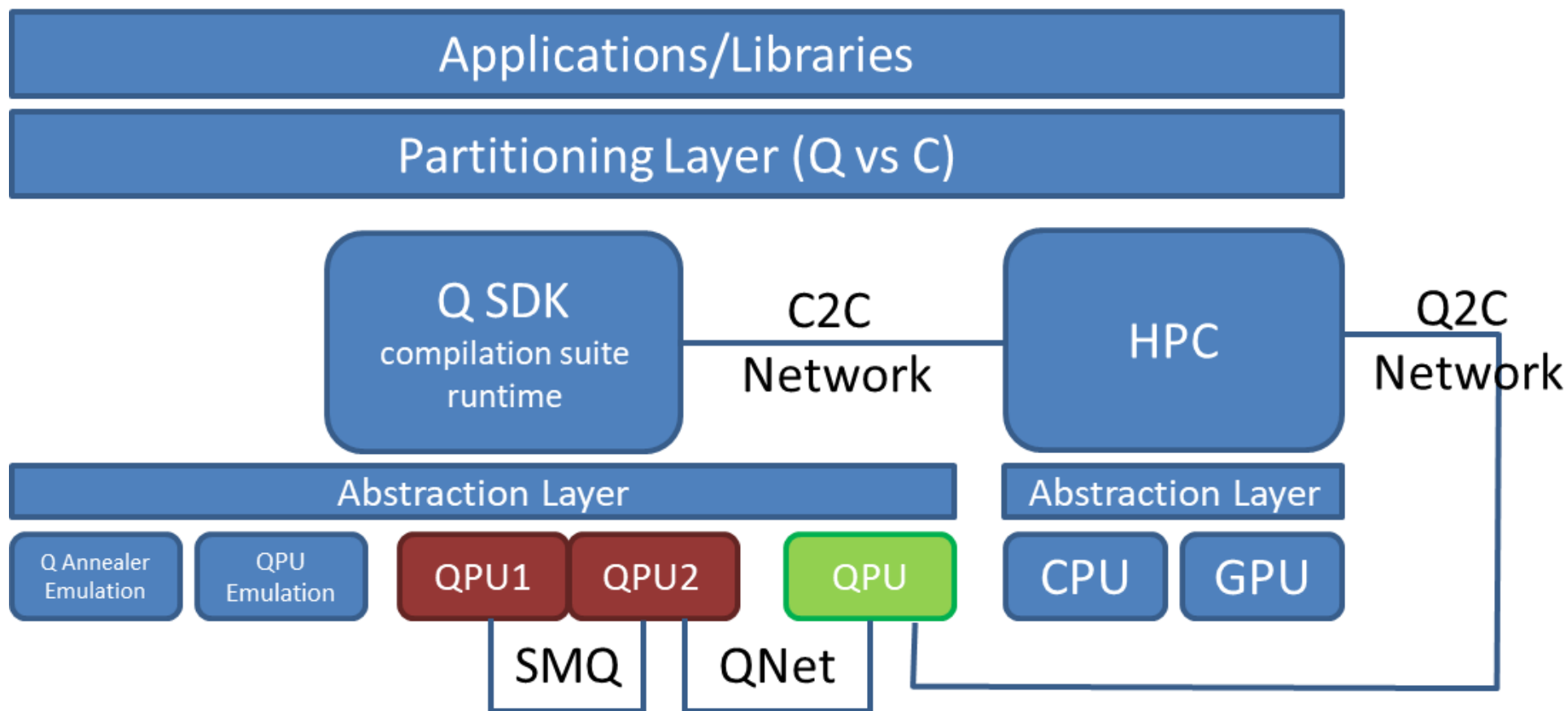
R&D programme with industrials and academics

Results will be implemented on the platform

Mains thematic are:

- **Pilot design and deployment**
 - QPU integration and hybrid architecture (QLM, Cloud, HPC, ...)
 - Software environment (development tools, runtime)
- **Applications**
 - Optimization and machine learning
 - Simulation of physical systems
- **Exploration**
 - Noise characterization and mitigation
 - Quantum links for secure/safe/reliable global computation

Programme Organization: Platform Architecture



- All QPU will use the same SW stack based on Atos QLM + R&D developments
- Direct access to QPU will be supported
- Designed for NISQ and LSQ

Dissemination, user support, usage (application)

HQI technologies access through a **cloud-based** solution

Cloud Provider will provide access to similar QC resources found in the hybrid HPC/QC platform to academics (R&D, training, etc.)

Hybrid QC dissemination

Establish a network of **French quantum competence centres** (label "Maison du Quantique »)

Dissemination, training, acculturation (e.g. **workshops, hackathons**, etc.)

Scientific and industrial **use cases development**: National Quantum PAcK and European Quantum Packs (ex. through a quantum CoE transversal to existing HPC CoEs)



Thank you for your attention

