The European High Performance Computing Joint Undertaking

EuroHPC – Hybrid HPC-QC from a policy maker perspective

2nd TQCI International Seminar on Benchmarks for QC - Reims | 05.06.2024 | Dr. R. S. Chatwell

From the Quantum Flagship to EuroHPC

EuroHPC Joint Undertaking

RESEARCH BASED

HORIZON EUROPE

2021-2027

INFRASTRUCTURES

DIGITAL EUROPE

Flagship

Bring quantum **technologies** from the **lab** to the **market** and consolidate European scientific **leadership** in quantum research

Fundamental R&D

Technology Supply

European Chips Act

Bolster Europe's competitiveness & resilience in semiconductors & **quantum chips** including production facilities & Quantum Fund

Procuring commercial products via open procedures

From Lab to Market

Pilot Lines & Testing Facilities

Advanced Digital Skills

Develop short term **training courses** and **Master's programmes** in key capacity areas

EuroQCI

Build and **deploy** in the next decade a certified secure pan-European end-to-end QCI for **cybersecurity services**

QKD Infrastructure

EuroQCS

Build and **deploy** an infrastructure for high performance computing and quantum computing

HPC with Accelerators

Stand-alone Q Computers

Ecosystem creation and building technological and business capabilities in Europe

EuroHPC – Quantum Computing Fleet

- **2 Quantum Simulators* (HPCQS)**
  - Jülich: *Jewels – PASQAL QS (Germany)* (100+)
  - GENCI: *Joliot-Curie – PASQAL QS (France)* (100+)
  - ➢ Both systems will be operational in **December 2024**
- **6 Selected Hosting "Entities" (Consortia of 30 participants) (1st CFEI)**
  - Euro-Q-Exa, *superconducting Qubits* (DE) (50/100)
  - LUMI-Q, *superconducting Qubits* (CZ) (20+)
  - EuroQCS-Spain, *superconducting Qubits* (ES)† (10)
  - EuroQCS-Italy, *neutral atom Qubits* (IT)* (100+)
  - EuroQCS-Poland, *trapped ion Qubits* (PL) (20)
  - EuroQCS-France, *photonic Qubits* (FR) (10+)
  - ➢ First systems expected to be operational in **Q3 2025**
- **2-3 Additional Hosting "Entities" (2nd CFEI)**
  - ➢ First systems expected to be operational in **Q2 2027**

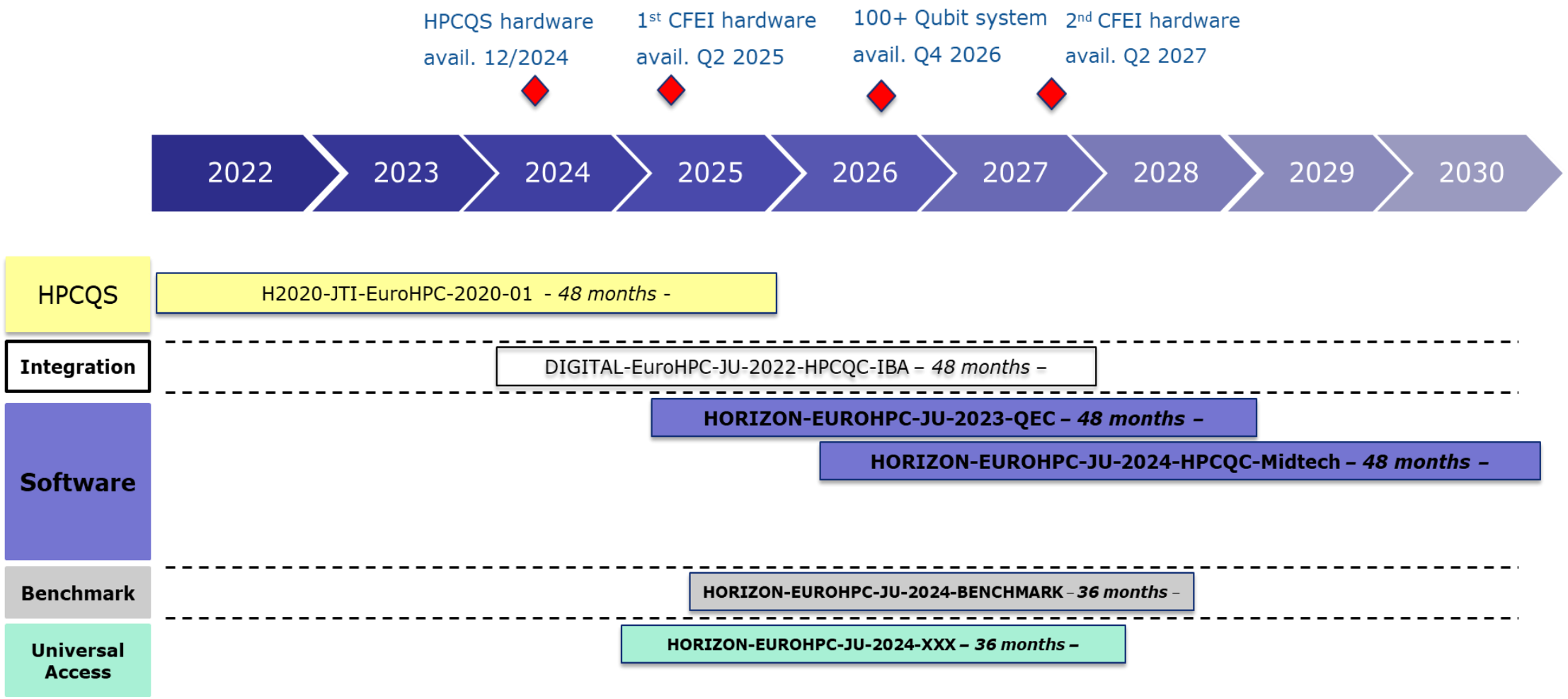
*) Analogue/ digital Quantum Simulator †) Analogue Quantum Annealer

Total hardware investment: **~ 145 Mio. EUR**

EuroHPC – Applied QC Benchmarks

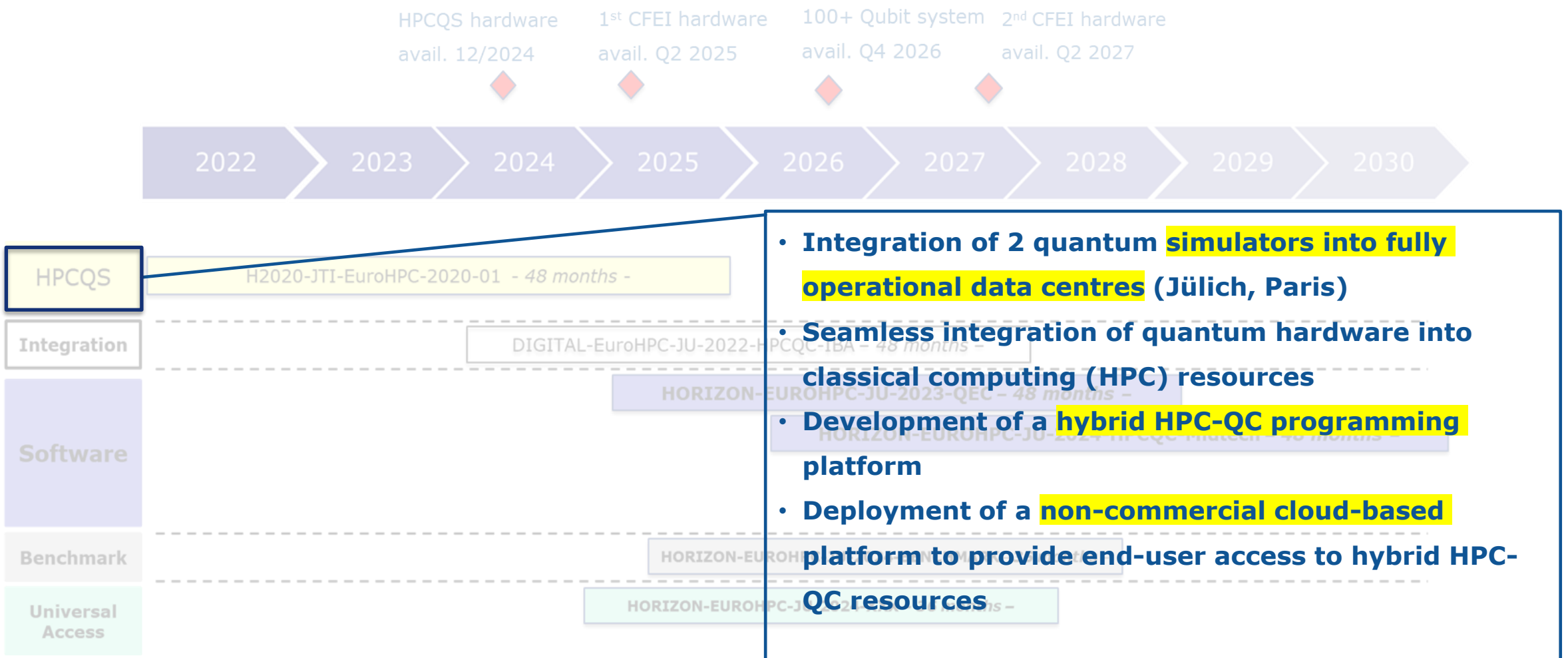
	Simple hardware metrics	Hardware efficiency metrics	Application/ Performance
Trapped-ion	• Native gate fidelities (Rx, Ry, Rz, Toffoli) • Greenberger-Horne-Zeilinger (GHZ) states		• Grover's algorithm • Quantum Fourier transform (QFT) • Variational Quantum Eigensolver (VQE) • Quantum Approximate Optimization Algorithm (QAOA) • Quantum Support Vector Machine (QSVM)
Superconducting	• Native gate fidelities (T, CNOT, Toffoli) • Greenberger-Horne-Zeilinger (GHZ) states		• Quantum Volume (QV) • Circuit Layer Operations per Second (CLOPS) • Variational Quantum Eigensolver (VQE) • Quantum Approximate Optimization Algorithm (QAOA) • Deutsch-Josza Algorithm • 1D-Heisenberg chains • Monte Carlo (MC) sampling • Quantum Phase Estimation (QPE) • Q-Score (Max-cut application)
Photonic	• Native gate fidelities (T, CNOT, Toffoli) • Greenberger-Horne-Zeilinger (GHZ) states	• Photon source • Quantum circuit loss • Photon loss • Photodetector	• Quantum LINPACK • Q-Score (Max-cut application) • Variational Quantum Eigensolver (VQE)
Neutral Atoms			• Ising antiferromagnet in 1D and 2D Arrays • Quantum Approximate Optimization Algorithm (QAOA) • Quantum Adiabatic Algorithm (QAA)

EuroHPC – Planned Funding Activities



Total software investment: + **94 Mio. EUR**

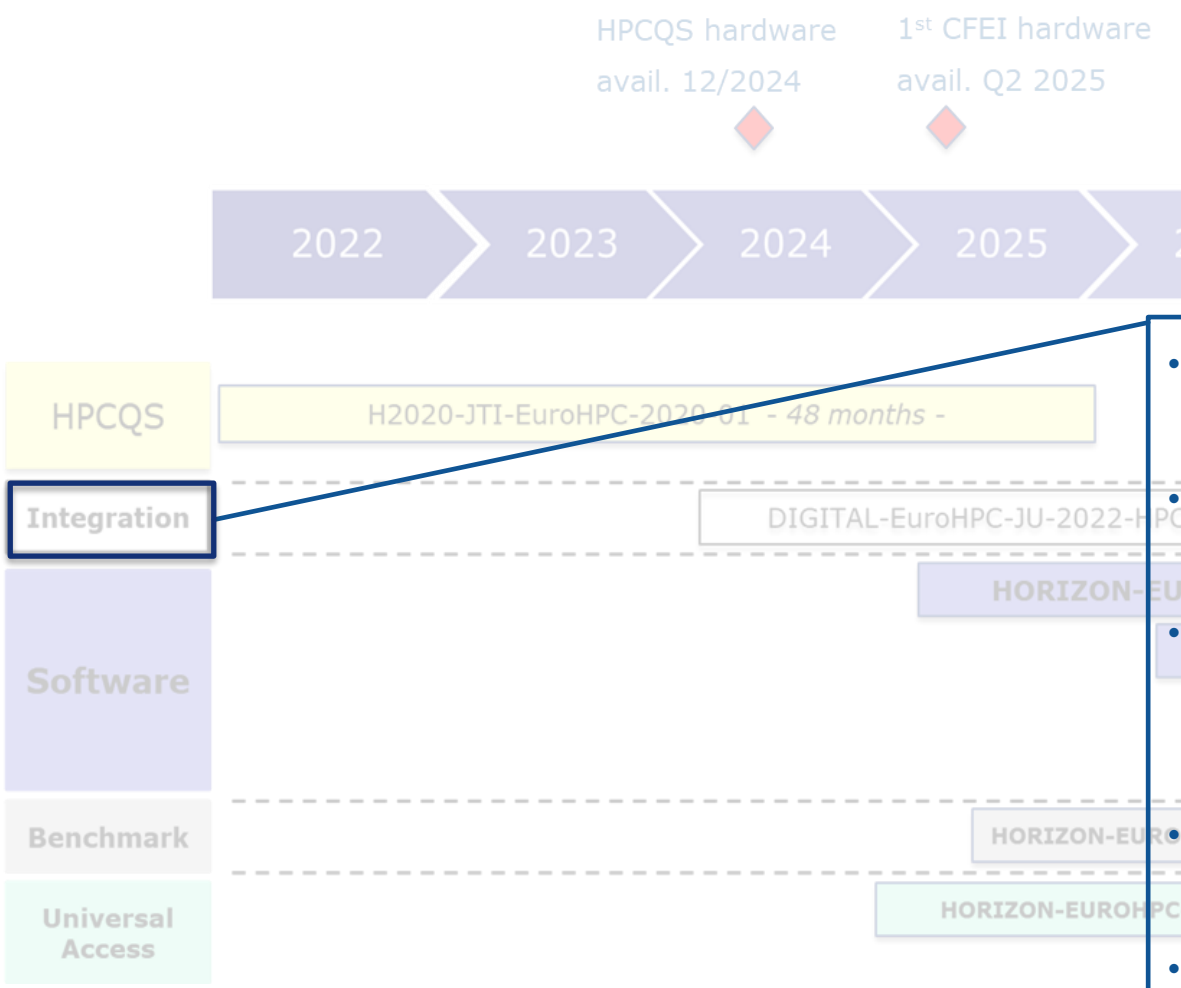
EuroHPC – Planned Funding Activities



- **Integration of 2 quantum simulators into fully operational data centres (Jülich, Paris)**
- **Seamless integration of quantum hardware into classical computing (HPC) resources**
- **Development of a hybrid HPC-QC programming platform**
- **Deployment of a non-commercial cloud-based platform to provide end-user access to hybrid HPC-QC resources**

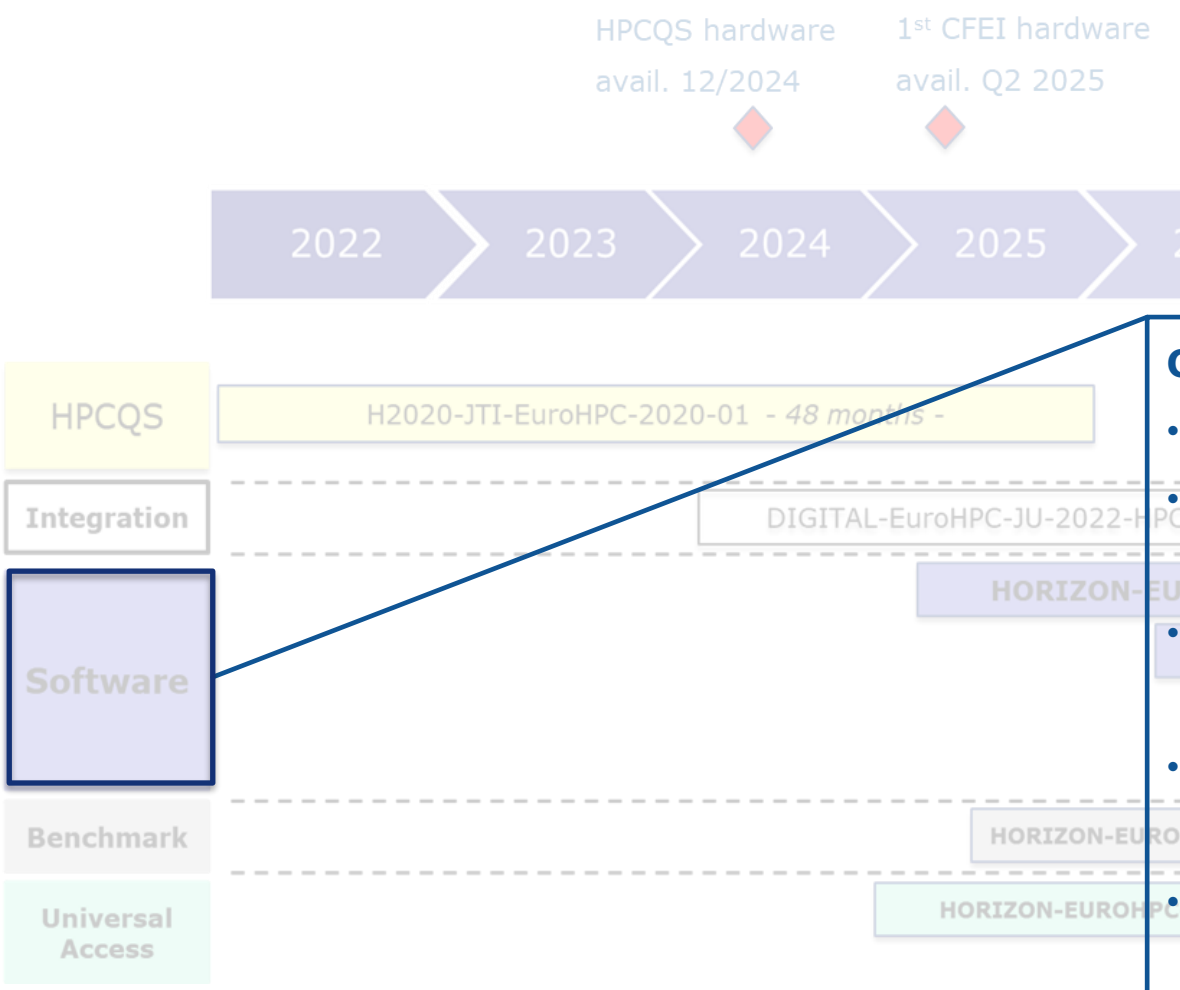
https://www.hpcqs.eu/

EuroHPC – Planned Funding Activities



- Development of **proof-of-concept applications** and **benchmarks** for hybrid HPC-QC workflows
- Establishing **High-Level Support Teams** (HLST) to actively engage with and support the user community
- Development of **hardware agnostic application programming interfaces** (API) and system management interfaces
- Development of harmonised **resource allocation** tools (i.e. job scheduler)
- Active contribution to **standardisation** efforts through CEN/CENELEC

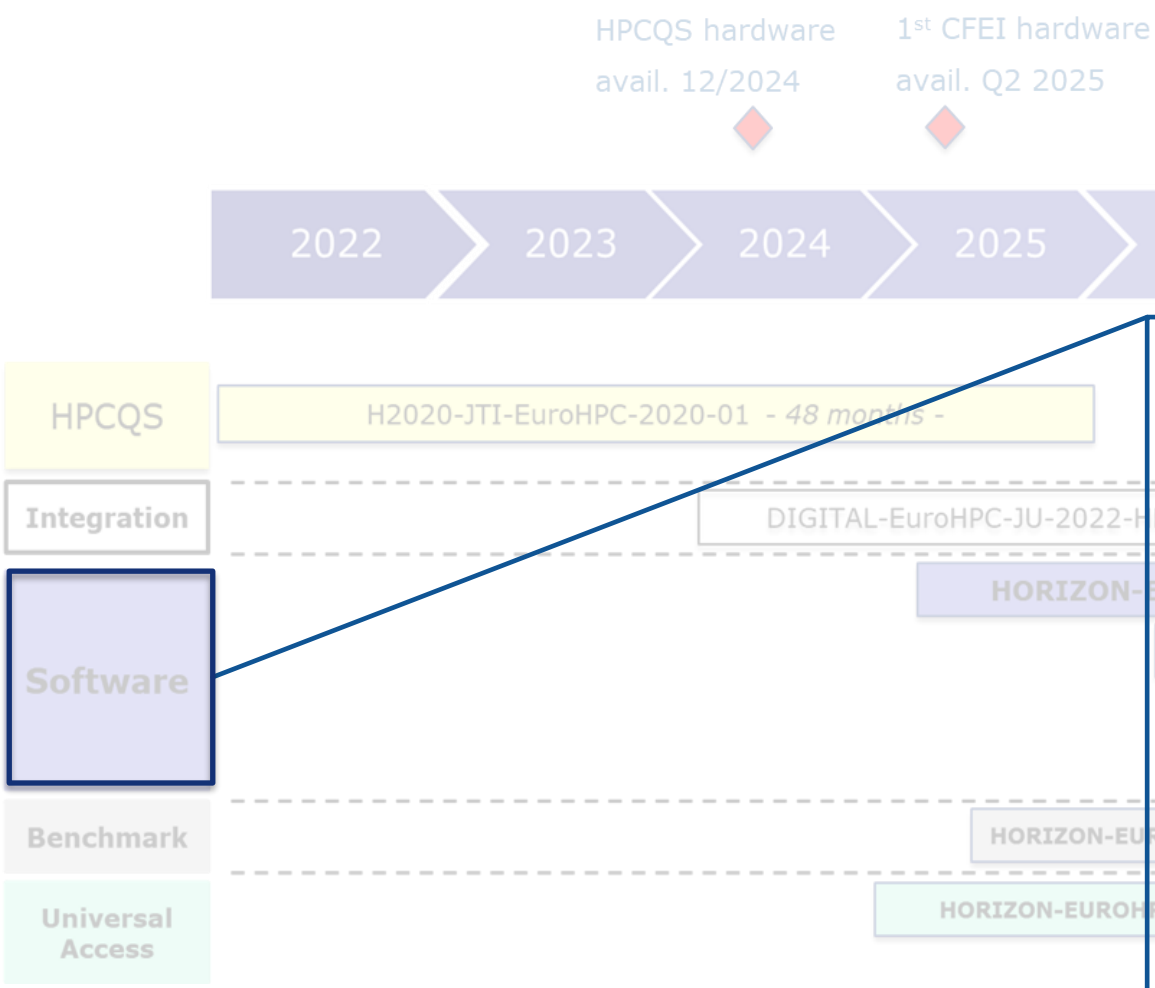
EuroHPC – Planned Funding Activities



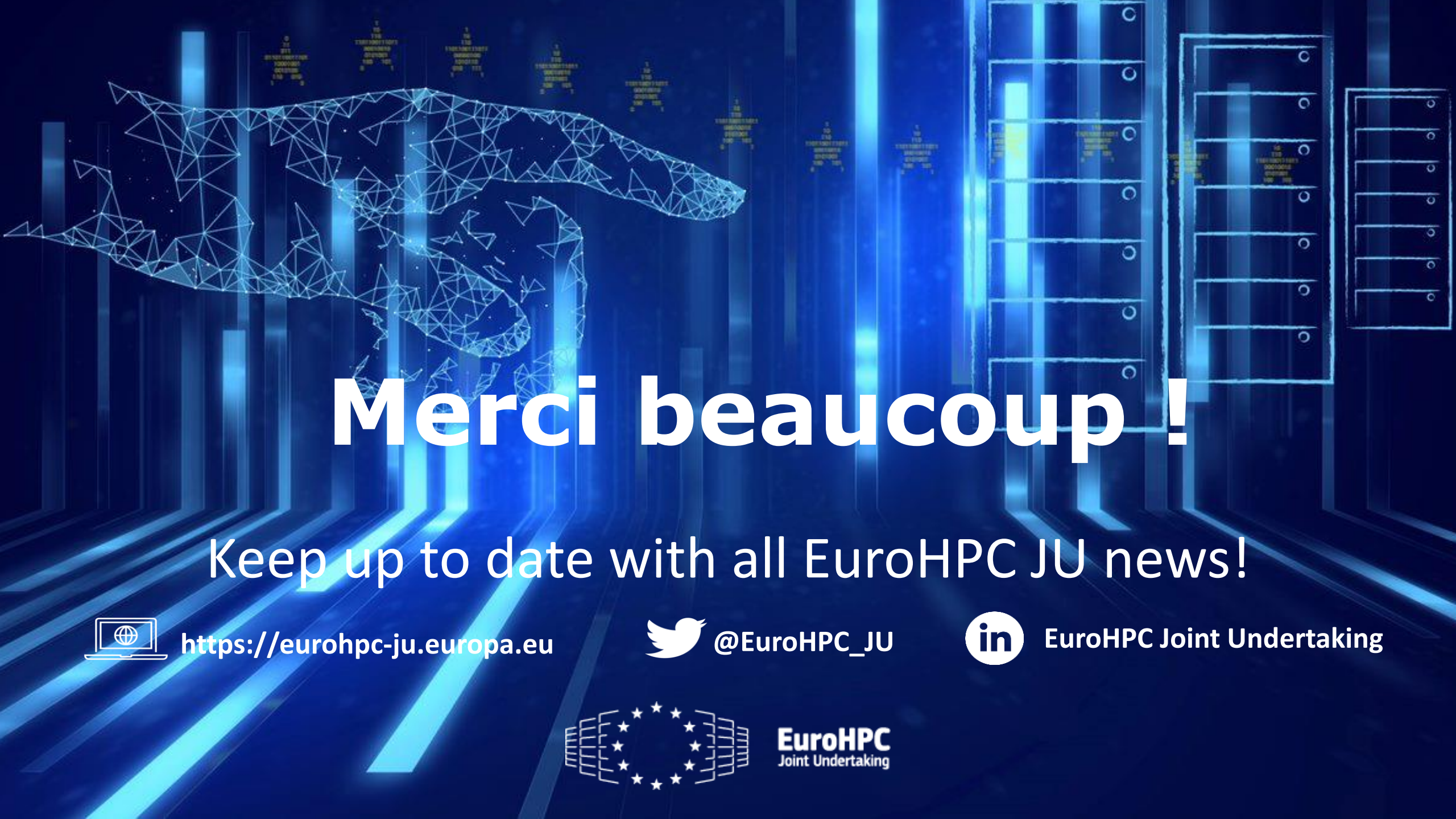
Quantum-Excellence Centre Call (QEC):

- **Will engage pro-actively in community building**
- **Development of novel quantum-oriented application areas**
- **Development and advancements of quantum algorithms, -libraries and application software**
- **Test and validation of codes for multitude of different QC platforms**
- **QECs shall establish themselves as service providers and "one-stop-shops" for relevant target groups.**

EuroHPC – Planned Funding Activities



- **Middleware:**
- **Vertical decomposition across the full software stack**
- **Focussing on modular hardware agnostic software stack**
- **Spanning from quantum algorithms to frameworks, to quantum resource manager**
- **Fostering tight integration into HPC systems**
- **Close collaboration with other Quantum Flagship and EuroHPC initiatives**


Merci beaucoup !
Keep up to date with all EuroHPC JU news!
https://eurohpc-ju.europa.eu
@EuroHPC_JU
EuroHPC Joint Undertaking
EuroHPC
Joint Undertaking