GENCI/CEA, FZJ, and PASQAL Announce Significant Milestone in Hybrid Computing

Concrete First Results on 100+-Qubit HPCQS Systems Pave the Way for Hybrid HPC/Quantum Applications

Denver, November 9th 2023

In the context of the SuperComputing 2023 conference in Denver (SC23), Grand Equipement National de Calcul Intensif (GENCI), Commissariat à l'énergie atomique et aux énergies alternatives (CEA), Forschungszentrum Jülich (FZJ), and PASQAL are demonstrating progresses in the framework of the European project High-Performance Computer and Quantum Simulator hybrid (HPCQS). Indeed, HPC-Quantum Computing applications in finance, pharma, and energy are leveraging the upcoming quantum computers that are currently being installed at the supercomputing centers CEA/TGCC (France) and FZJ/JSC (Germany), providing already concrete results.

Now, PASQAL is delivering two 100+-qubit quantum computers to its first customers in France (GENCI/CEA) and Germany (FZJ). These devices, acquired in the framework of the European project HPCQS, and co-funded by the EuroHPC Joint Undertaking, France and Germany, will be coupled respectively with the Joliot-Curie and JURECA DC supercomputers.

Over the past months, several HPC-Quantum Computing and Simulation (HPC-QCS) applications have been studied on the targeted 100+-qubit quantum computing platform based on neutral atoms. These explorations have involved several industrial partners from various fields who provided practical use cases that, with the support of the PASQAL team, were ported on the quantum system, enabling the development of more efficient drugs, more efficient electricity consumption, and competitive advantage in risk management.

A significant illustration of this is the development of a novel quantum algorithm to accelerate drugs discovery. A joint collaboration between PASQAL and the Qubit Pharmaceuticals startup has been launched end of 2021, co-funded by the Pack Quantique (PAQ) initiative of the Region Ile-de-France for an 18-month project. This collaboration aims at improving the understanding of protein hydration, a crucial element in determining how the medicine candidate can inhibit the toxic behaviour of the targeted protein. A preliminary version of the algorithm for identifying the presence of water molecules in the pockets of a protein has been implemented on PASQAL's analog quantum computer to validate theoretical predictions with

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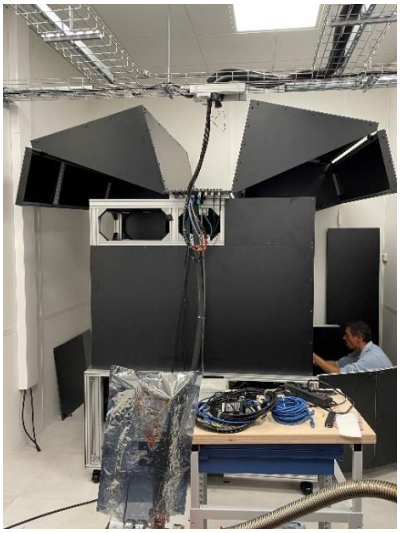
impressive match. The follow up of this project is being co-funded by the Wellcome Trust Quantum for Bio programme.

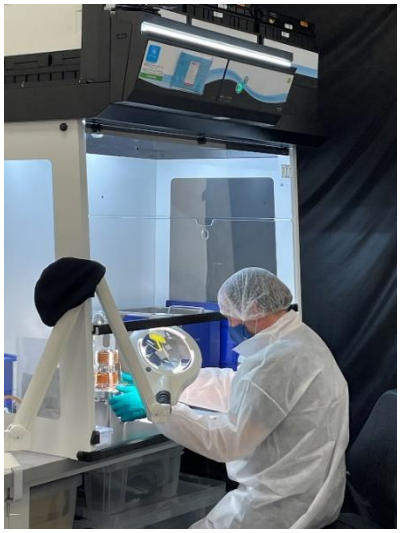
PASQAL will showcase this exploration in favour of commercial and strategic advantages on the booths of both CEA and FZJ/JSC at the SuperComputing 2023 conference in Denver through live demos.

The two PASQAL quantum computers will be accessible to a wide range of European users in 2024. They are the first building blocks of a federated European HPC-QCS infrastructure that will also consist of the six quantum computers acquired by the EuroHPC JU and hosted in France (GENCI/CEA), Germany (LRZ), Czech Republic (IT4I @ VSB), Poland (PSNC), Spain (BSC-CNS) and Italy (CINECA).

HPCQS users are already able to validate their use cases through various entry points, such as the Pulser environment deployed on the Joliot-Curie and JURECA DC environments, as well as thanks to remote access to a 100+-qubit device hosted on PASQAL's premises in Massy, France. Currently, some HPCQS users from JSC are performing remote simulations on this device to benchmark it and to demonstrate quantum many-body scarring, a phenomenon that has recently attracted a lot of interest in foundations of quantum statistical physics and potential quantum information processing applications. European end-users will also soon have access to a more scalable, tensor network-based emulator from PASQAL, called EMU-TN, which will also be deployed on both French and German environments.



PASQAL's Fresnel 1 Computer work in progress in the delivery of the computers © PASQAL



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About HPCQS

HPCQS is an open and evolutionary infrastructure that aims at expanding in the future by including a diversity of quantum computing platforms at different technology readiness levels and by allowing the integration of other European quantum nodes. The HPCQS infrastructure realises, after the Jülich UNified Infrastructure for Quantum computing (JUNIQ), a second step towards a European Quantum Computing and Simulation Infrastructure (EuroQCS), as advocated for in the Strategic Research Agenda of the European Quantum Flagship of 2020. At FZJ, HPCQS is fully integrated in JUNIQ. During the preparations for the Strategic Research and Industry Agenda (SRIA 2030) for Quantum Technologies in the European Union, the name of the EuroQCS infrastructure was changed to EuroHPC-QCS to emphasize the involvement of HPC as well.

Project Key Facts

Acronym	HPCQS
Title	High-Performance Computer and Quantum Simulator hybrid
Start date	1st December 2021
Duration	4 years
Budget	€ 12 Mil (50% funded by EuroHPC JU)
Coordination	Forschungszentrum Jülich, Prof. Dr Kristel Michielsen
Partners	FZJ, CEA, GENCI, BULL, CNR, NUIG-ICHEC, University of Innsbruck, EURICE, CNRS, Inria, CINECA, BSC, FlySight, ParityQC and Fraunhofer IAF
Linked 3rd parties	ParTec, Sorbonne Université and CentraleSupélec
Website	www.hpcqs.eu
X	https://twitter.com/HPCQS_EU
LinkedIn	https://www.linkedin.com/showcase/hpcqs-eu

About GENCI

Created by the public authorities in 2007, GENCI is a major research infrastructure. This public operator aims to democratise the use of digital simulation through high performance computing associated with the use of artificial intelligence, and now quantum computing, to support French scientific and industrial competitiveness.

GENCI is in charge of three missions:

- To implement the national strategy for the provision of high-performance computing resources, storage and processing of massive data associated with AI technologies for the benefit of French open scientific research in conjunction with the three national computing centers.
- Support the creation of an integrated HPC ecosystem at the national and European levels.
- Promote digital simulation through HPC to academic research and industry scale.

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GENCI is a civil company, 49% of which is owned by the French government, represented by the Ministry of Higher Education and Research, 20% by the CEA, 20% by the CNRS, 10% by Universities represented by France Universités and 1% by Inria.

About CEA

The CEA is tasked with guiding public decisions and providing the scientific and technical means that civil society (businesses and local authorities) needs to better manage major societal changes, such as the energy transition, digital transformation, future healthcare, defence and global security. Its mission is supported by 20,000 employees and 9 research centres equipped with major research facilities that provide an innovative environment conducive to academic and industrial partnerships in France, Europe and abroad. For more information visit www.cea.fr

About FZJ

Shaping change: This is what drives us at Forschungszentrum Jülich. As a member of the Helmholtz Association with roughly 7,000 employees, we conduct research into the possibilities of a digitised society, a climate-friendly energy system, and a resource-efficient economy. We combine natural, life and engineering sciences in the fields of information, energy, and the bioeconomy with specialist expertise in high-performance computing and we also use unique scientific infrastructure.

About PASQAL

PASQAL builds quantum computers from ordered neutral atoms in 2D and 3D arrays to bring a practical quantum advantage to its customers and address real-world problems. PASQAL was founded in 2019, out of the Institut d'Optique, by Georges-Olivier Reymond, Christophe Jurczak, Professor Dr Alain Aspect, Nobel Prize Laureate Physics, 2022, Dr Antoine Browaeys, and Dr Thierry Lahaye. PASQAL has secured more than €140 million in financing to date.

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