EuroQHPC-Integration

Towards a pan-European hybrid HPC-QC platform

Sabine Mehr
GENCI

Martin Schulz
LRZ/TUM/MQV

A bit of context on the EuroHPC Quantum Computing initiative…

THE EUROHPC QUANTUM COMPUTING INITIATIVE

Two pilot systems acquired for the HPCQS project

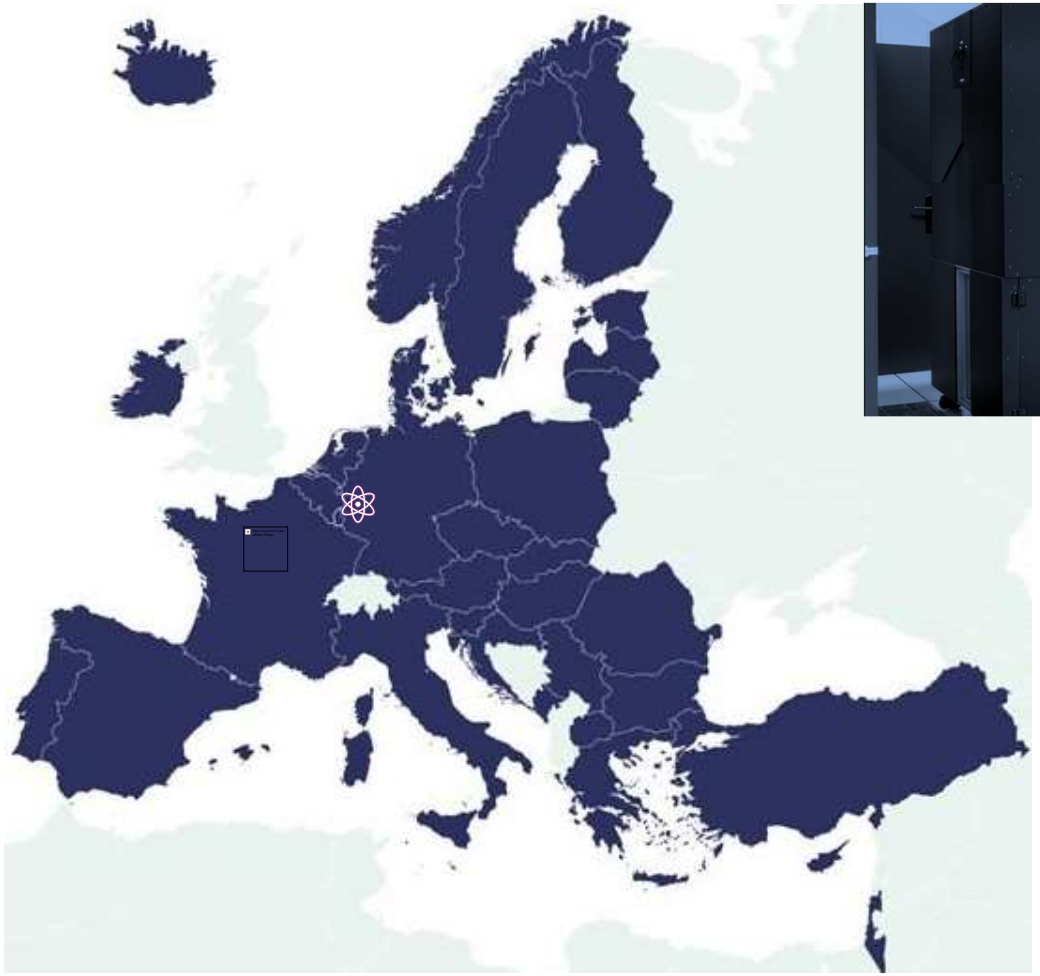
2 **100+-qubit quantum simulators** acquired in the context of ⟨HPC|QS⟩

GENCI/CEA **RUBY**

FZJ **JADE**

15 **partners** in total

6 **countries** involved



THE EUROHPC QUANTUM COMPUTING INITIATIVE

Six additional quantum computers acquired

6 **10+-qubit quantum computers** acquired through a call for expression of interest (CEI)

30 **partners** in total

17 **countries** involved

EuroQCS-France
GENCI/CEA

Euro-Q-Exa
LRZ

EuroQCS-Italy
CINECA

Lumi-Q
IT4I @ VSB

EuroQCS-Poland
PSNC

EuroQCS-Spain
BSC-CNS

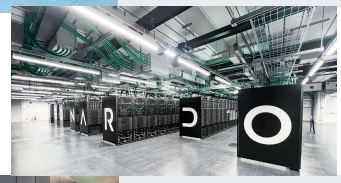
THE EUROHPC QUANTUM COMPUTING INITIATIVE

Six additional quantum computers acquired

	**EuroQCS-France** GENCI/CEA	**LUCY**	Photonic quantum computer	QUANDELA
	**Euro-Q-Exa** LRZ		Superconducting qubits	IQM
	**EuroQCS-Italy** CINECA	**SOL**	Neutral atoms	PASQAL
	**Lumi-Q** IT4I @ VSB	**VLQ**	Superconducting qubits with a star-shaped topology	IQM
	**EuroQCS-Poland** PSNC	**PIAST-Q**	Trapped ions	AQT
	**EuroQCS-Spain** BSC-CNS	**MN-ONA**	Quantum annealer	QILIMANJARO QUANTUM TECH

THE EUROHPC QUANTUM COMPUTING INITIATIVE

Seven different flavors of HPC-QC infrastructures

EuroQCS-France GENCI/CEA	LUCY	Photonic quantum computer	PASQAL QUANDELA	 
Euro-Q-Exa LRZ		Superconducting qubits	IQM	
EuroQCS-Italy CINECA	SOL	Neutral atoms	PASQAL	
Lumi-Q IT4I @ VSB	VLQ	Superconducting qubits with a star-shaped topology	IQM	
EuroQCS-Poland PSNC	PIAST-Q	Trapped ions	AQT	
EuroQCS-Spain BSC-CNS	MN-ONA	Quantum annealer	QILIMANJARO QUANTUM TECH	

How are these centers collaborating on HPC-QCS integration?

THE EUROHPC QUANTUM COMPUTING INITIATIVE

The EuroQHPC-Integration project

Coordinated by GENCI

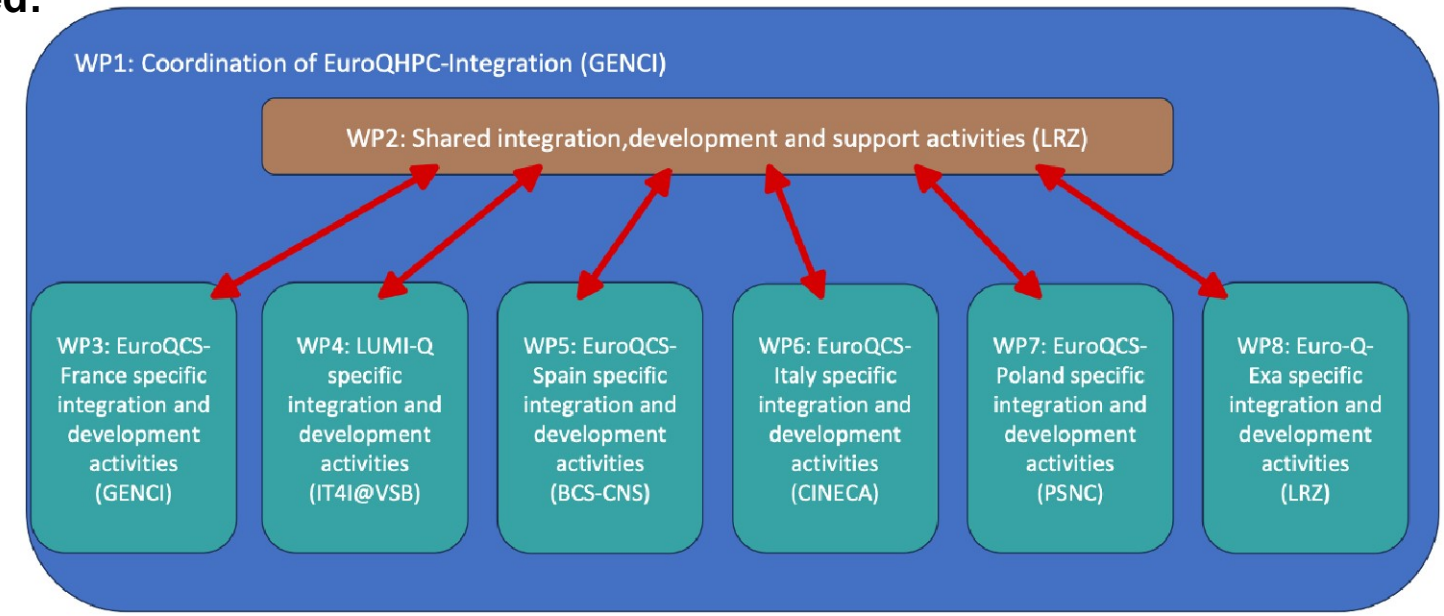
Partners & affiliated entities involved:
all partners from the initial
six grant applications to
EUROHPC-22-CEI-QC-01

Duration: 48 months

Budget: €15M

Goal: harmonize the respective
HPC-QC integration strategies
for all EuroHPC quantum devices,
connect to the work carried out
within ⟨HPC|QS⟩

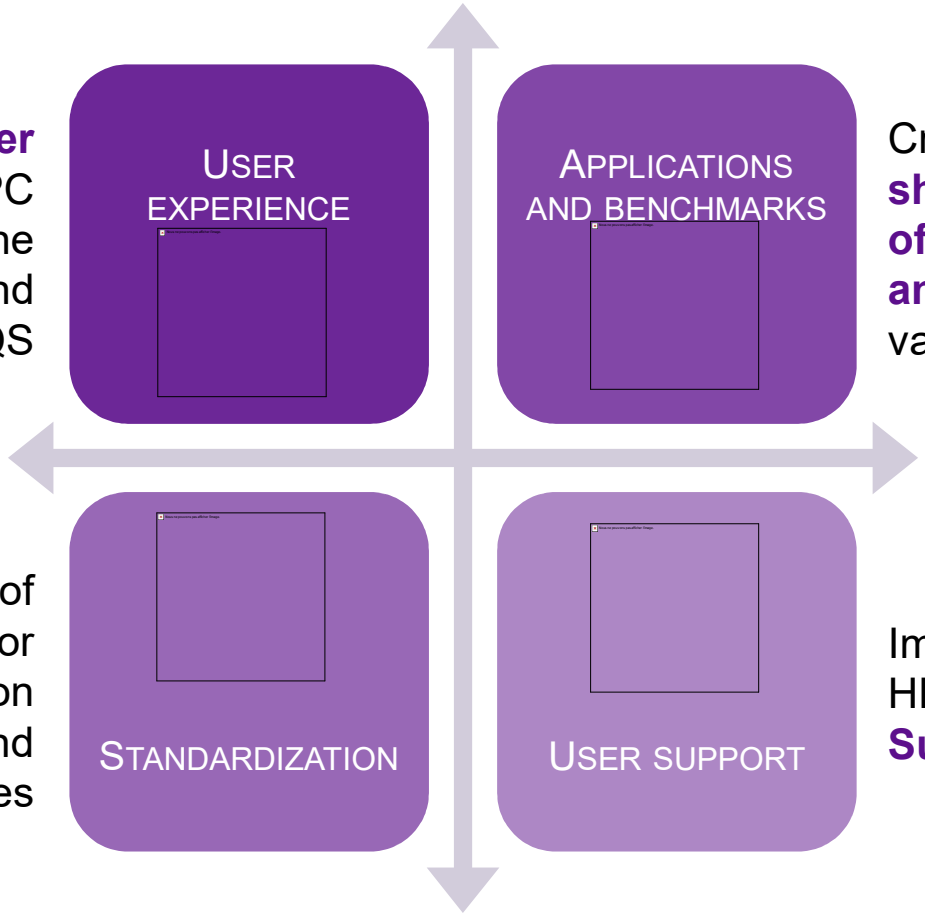
Status:
The project is running !



THE EUROHPC QUANTUM COMPUTING INITIATIVE

The EuroQHPC-Integration project: topics addressed in WP2

Harmonization of the user experience for the EuroHPC quantum systems across the six Hosting Entities and HPCQS



Creation of a repository of **shared collection of proof-of-concept applications and benchmarks** running on various hybrid systems

Collaboration with/Creation of **standardization bodies** for key interfaces and participation in relevant working groups and committees

Implementation of an HPC-QC **Technical Support Team**

THE EUROHPC QUANTUM COMPUTING INITIATIVE

Towards a Unified User Experience Across Centers and Communities

- **Harmonize the user experience** between the HPC-QCS platforms
- Exchange with the ⟨HPC|QS⟩ and **EuroHPC Federation of Resources** projects
- Seeking a **unified/federated access** to EuroHPC HPC-QCS resources
- Towards the use of **common tools** and **system environments**
  - Efficient **Co-scheduling** of HPC and QCS resources
  - Hardware-agnostic **programming** environments
  - **Reporting** the use of resources (time, performances, energy consumption) / **metrics**
  - Deployment of **European tools** and **abstraction libraries**

USER EXPERIENCE

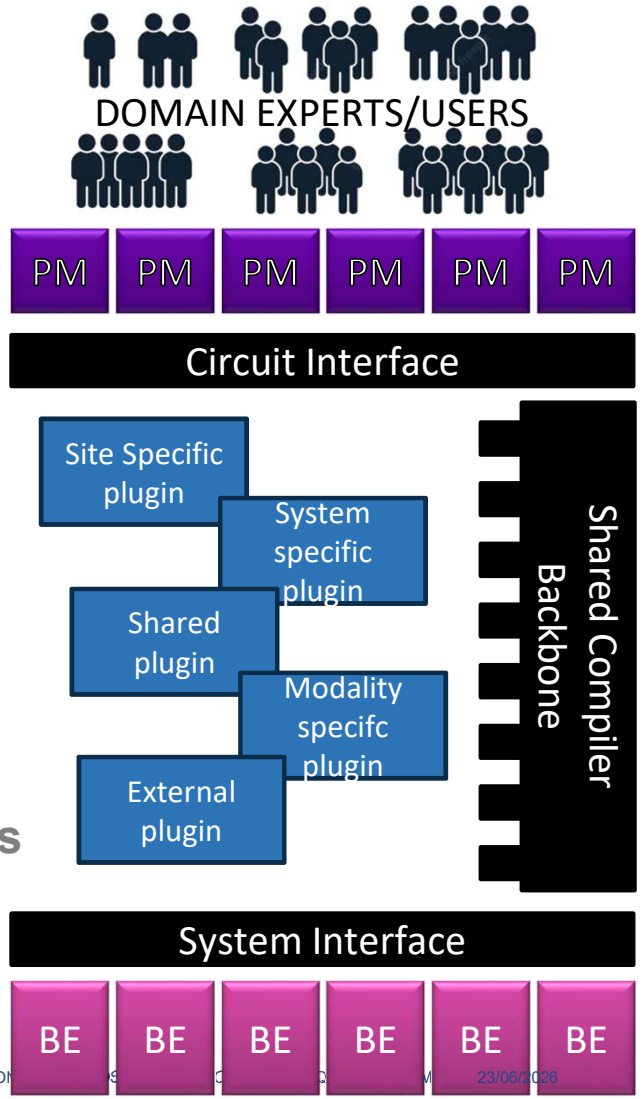
THE EUROHPC QUANTUM COMPUTING INITIATIVE

The Technical Vision Towards a Shared Software Stack

- Compare and share **local developments**

Vision: shared core infrastructure that is adjustable to site requirments to support sharing of local developments

- Central: shared **interfaces** and **representations**
  - Towards **common programming models** and **abstractions**
  - **Support/Backends** for all EuroHPC systems
  - **Merging functionality** (e.g., compiler passes)



APPLICATIONS AND BENCHMARKS

THE EUROHPC QUANTUM COMPUTING INITIATIVE

Comparing Experiences and Helping Communities

- Creation of a **shared repository** of **proof-of-concept applications** and **benchmarks** running on all involved architectures
- End-users will assess **various QPUs** and **coupling strategies** with HPC systems
- **Finding the best fit between algorithms, workflows and hardware technologies**

THE EUROHPC QUANTUM COMPUTING INITIATIVE

Enabling Practical Use On and Across All Sites

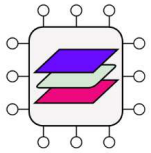
- Implementation of a shared HPC-QCS **Technical Support Team** (TST)
  - By pooling existing resources from each proposals and creating a **distributed workforce** that will collaborate in sharing best practices and experience
- Liaise with existing **Applications Support Teams (AST)** set up by EuroHPC
- **Support and train** end-users to use the various QCS systems exposed by EuroHPC
- Collaborate in **peer reviewing** the projects submitted to access the EuroHPC HPC-QCS platforms

STANDARDIZATION

THE EUROHPC QUANTUM COMPUTING INITIATIVE

Defining Shared Interfaces Across the EU Communities (and Beyond)

- Feedback to standardization efforts
  - As we are jointly moving forward with the HPC-QCS integration in Europe, it's crucial our experience and learnings are integrated in standards
- Liaise with existing **standardization bodies** and participate in **relevant working groups** and/or **support grass-root standardization efforts**



openQSE

CEN CENELEC Focus Group on Quantum Technologies

IEEE QUANTUM

BACQ MetriQs-France

THE EUROHPC QUANTUM COMPUTING INITIATIVE

And the The EuroQHPC-Integration project

WHERE DO WE STAND WITH SYSTEMS?

EuroQCS-France
GENCI/CEA

Euro-Q-Exa
LRZ

EuroQCS-Italy
CINECA

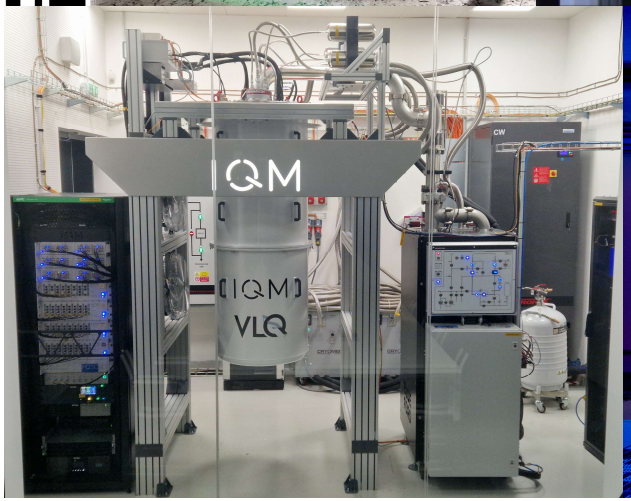
Lumi-Q
IT4I @ VSB

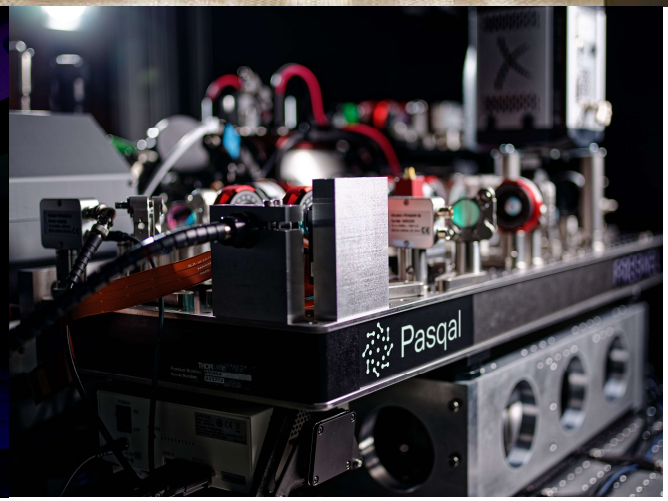
EuroQCS-Poland
PSNC

EuroQCS-Spain
BSC-CNS

THE EUROHPC QUANTUM COMPUTING INITIATIVE

And the The EuroQHPC-Integration project





EuroQHPC-I

The Latest Additions to the Hosting Entities selected by EuroHPC

EUROSSQ-HPC

MELUXINA-Q

Bringing Together the European HPC-QCS User and System Eco-Systems

Sabine Mehr
GENCI
sabine.mehr@genci.fr

Martin Schulz
LRZ/MQV/TUM
schulzm@in.tum.de

EuroQHPC-I