TQCI

Integrating quantum computers into CEA's TGCC Compute Center

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OUTLINE

1. CEA DIF and TGCC presentation
2. TGCC technical infrastructure
3. Specific issues with quantum machine at TGCC services
4. Next step and Feedback

1. CEA DIF and TGCC presentation

CEA DAM Ile-de-France

- A first rank research centre in Essonne (south Paris)
  - ~2000 employees, ~100 PhD and postdoctoral students
  - A large usage of HPC resources dedicated to “civilian” (TGCC) or “defence” (TERA-EXA) applications

- Our missions at CEA/DIF
  - French and European research
  - Nuclear warheads design and certification (Simulation Program)
  - Fight against proliferation and terrorism
  - Alert to authorities (geophysical hazards, tsunami, …)

CEA HPC ressources for Research, Industry and Defence

1 site (CEA/DIF), 2 facilities and 4 computing centres, https://www-hpc.cea.fr/

TGCC Facility (open science)

Cold water DLC

Public research
France (GENCI) and Europe (EuroHPC)

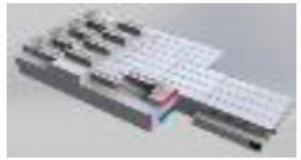
Joliot-Curie
22 Petaflop/s

Alice Recoque
1 Exaflop/s 2026

TOPAZE
10 Petaflop/s

CEA and **Industrial partners**
(CCRT)

OCRE
R&D Zone



TERA-EXA Facility (Defence)

Warm water DLC

CEA/DAM **Defence usages**
(EXA)

EXA1-HE
180 Petaflop/s

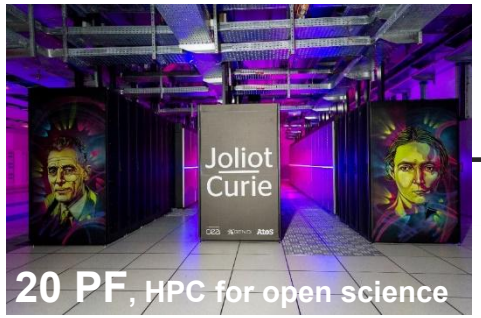
EXA1-HF
36 Petaflop/s

ECRIN
2 Petaflop/s

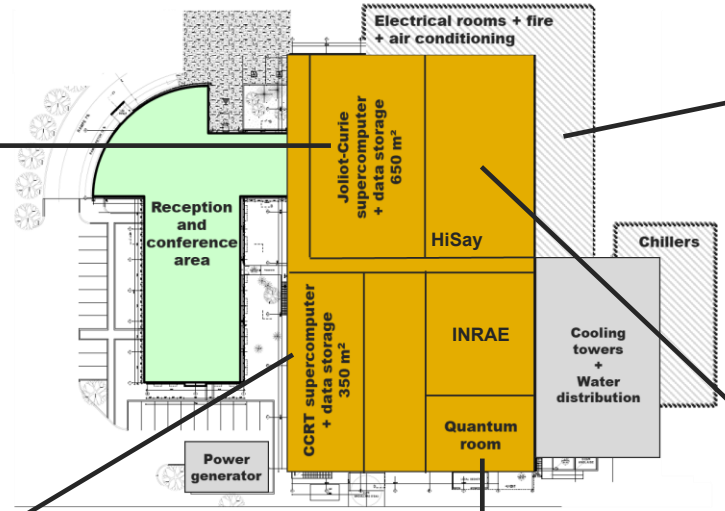
CEA and **Defence partners**
(CCMD)

TGCC, a world-class computing centre

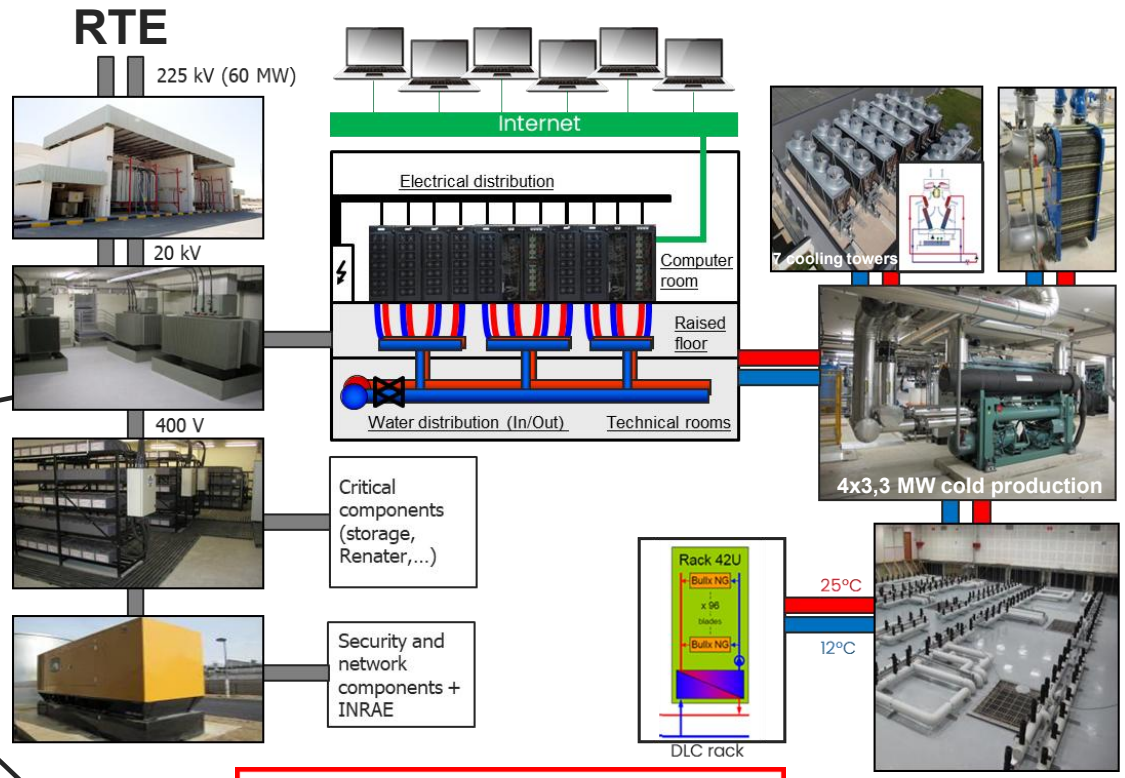
- **Built in 2010 to host and operate large scale supercomputers for HPC**
  - Computer rooms: 2600 m², technical zone: 3000 m²
  - Electrical power capacity: 2x30MW, **36 MW** configured
  - DLC capacity: **cold water 10 MW** & **warm water 20 MW**



GENCI



ccrt
Centre de calcul recherche et technologie



EuroHPC

GENCI

cea

Jules Verne project (**EuroHPC**),
1+EF HPL, 2026,
TGCC CEA, France

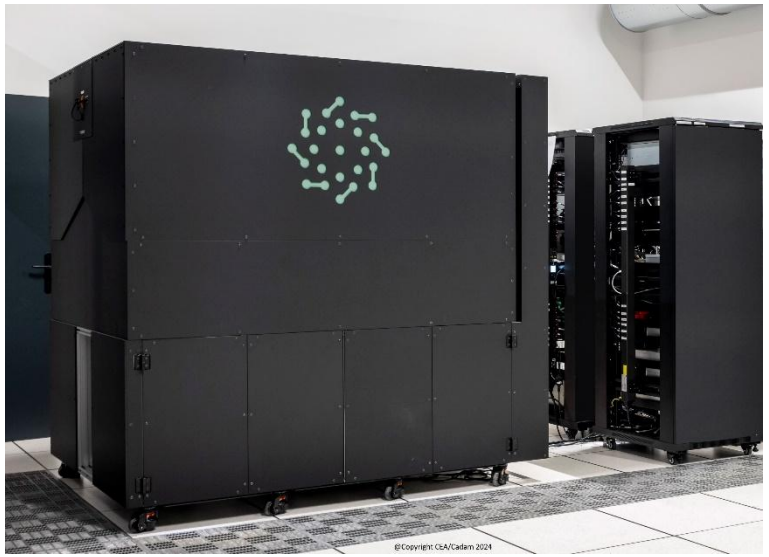
Quantum computing@TGCC

FRANCE HYBRID HPCQUANTUM INITIATIVE

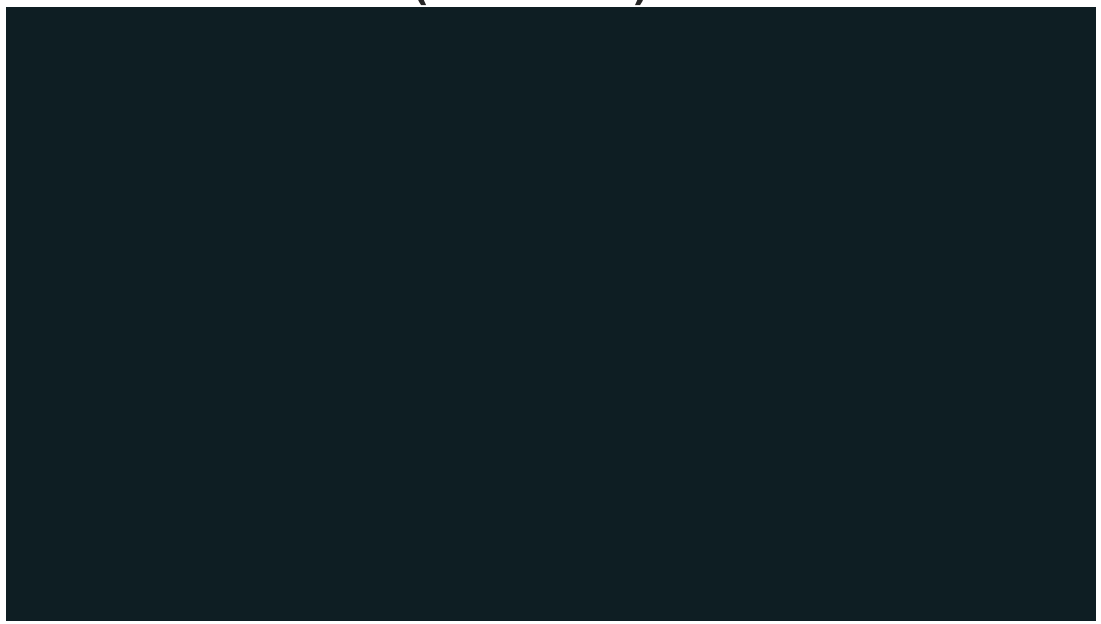
GENCI GRAND EQUIPEMENT NATIONAL DE CALCUL INTENSIF

EuroHPC Joint Undertaking

➢ RUBY : Pasqal's quantum simulator system, 100 qubits neutral atoms (Q3/2025)



⟨HPC|QS⟩



➢ LUCY : Quandela's photonic quantum system, 12 qubits (Q4/2025)

EuroQCS-France
GENCI/CEA

QUANDELA

attocube
WITTENSTEIN Group

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

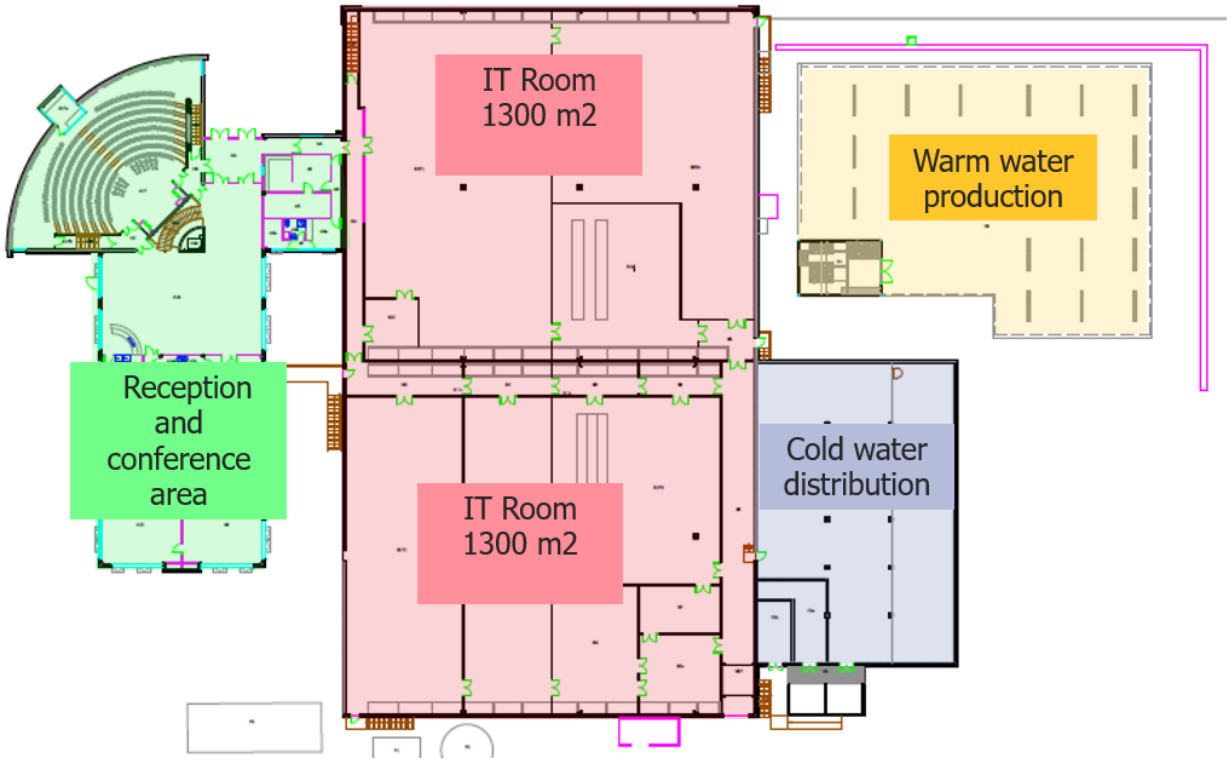
30 **partners** in total

17 **countries** involved

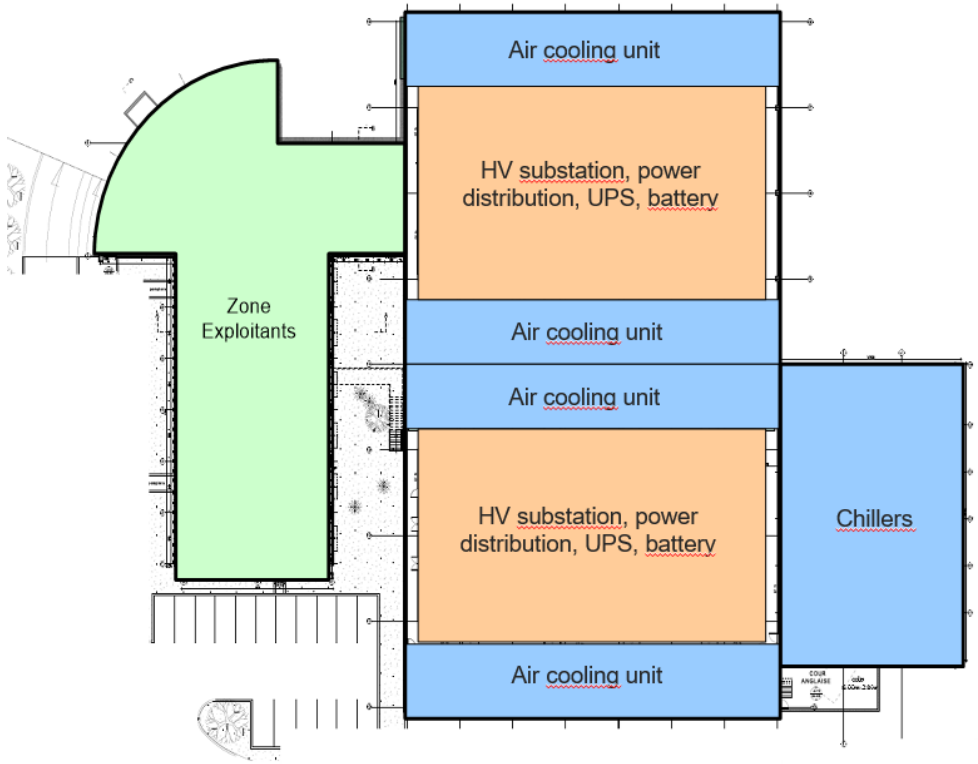
- **EuroQCS-France** GENCI/CEA
- **Euro-Q-Exa** LRZ
- **EuroQCS-Italy** CINECA
- **Lumi-Q** IT4I @ VSB
- **EuroQCS-Poland** PSNC
- **EuroQCS-Spain** BSC-CNS

2. TGCC technical infrastructure

Ground floor of the TGCC



Basement of the TGCC



Infrastructure – Electrical power distribution

TGCC :
2 loops HV

Distribution
HV 20 kV

Main transformer
225 kV/20 kV - 60 MW

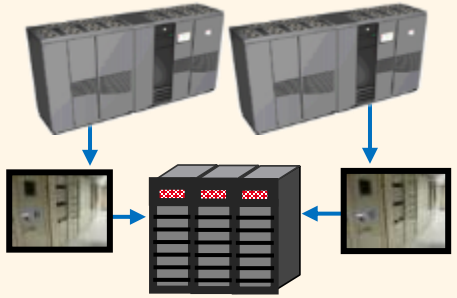
Electrical station Petit Bois

2 loops HV
225 kV

Backup power (diesel generator)

(Video, access control, Renater node, …)

Supply power (UPS)



Critical IT equipment
(storage, network,…)

Normal power

Computing nodes

TGCC : Power distribution

Infrastructure – Cooling

Seven dry-hybrid cooling towers

Four 3,3 MW chillers

Two 0,5 MW heat pump for heat recovery

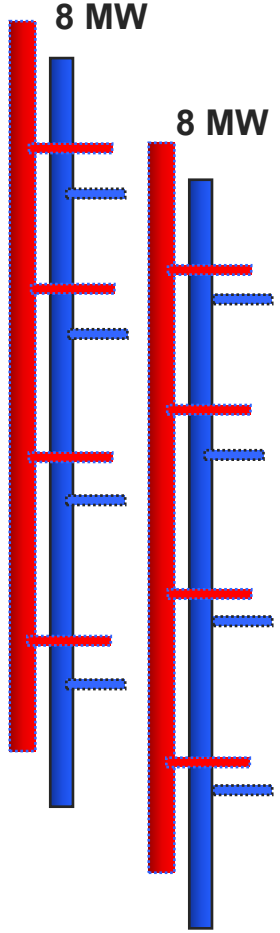
10 MW

Cold Water 9°C

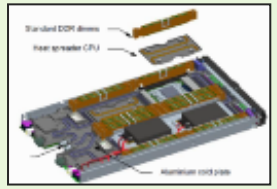
0,5 MW

0,7 MW

Hot water 55°C



Cube Inrow



Direct Liquid Cooling

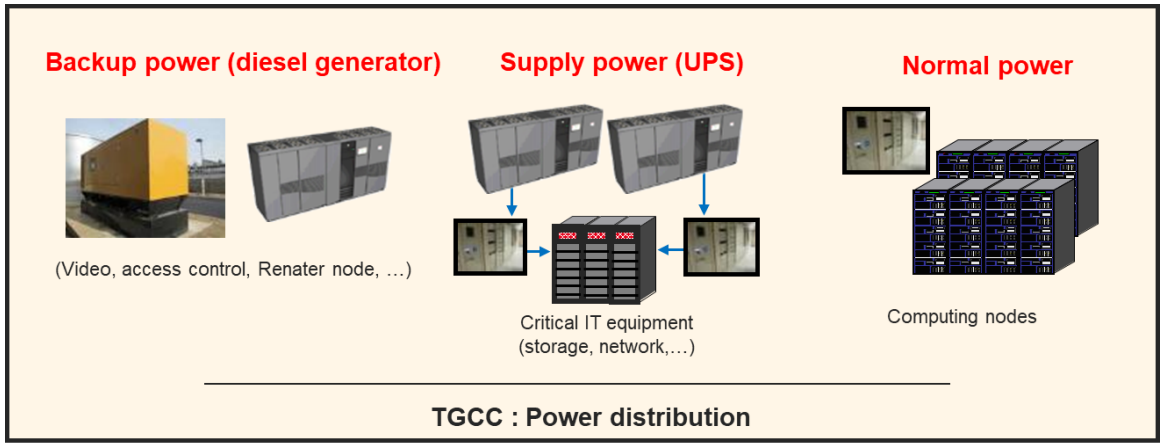
250 kW Air cooling unit IT room

100 kW Air cooling unit Electrical services room

3. Specific issues with Quantum machine at TGCC services

Power supply

- TGCC : Already 3 types of power supply
  - Normal
  - UPS
  - Backup



- It’s easy to add electrical cabinets as needed for quantum computer
  - We currently use supply power (UPS) for quantum computer
  - Using backup power is being considered (it was not in the initial specifications)

Cooling

- TGCC : Direct liquid cooling (85%) and air cooling (15%)
  - Currently a cold water loop at 9°C

- Quantum computer
  - Cold water is available at 9°C (it could be necessary to install a heat exchanger)
  - New air cooling units in the quantum room with flow reversal to prevent dust (from top to bottom)
  - More accurate temperature and humidity control

New hazards for personnel

- New risks to be considered
  - Laser
  - Anoxia
  - Pressurized equipment, …

- To tackle these risks, it was necessary to deal with these risks :
  - New procedures
  - New safety equipment
  - Safety files
  - Prevention plans, …

- Permission to operate a new facility at the TGCC depends on all of this, and the safety culture is very different between the CEA computing center and the quantum world.

4. Next step and Feedback

Next step and Feedback

- After installing Ruby and Lucy at TGCC, we should soon be welcoming a third quantum computer, based on superconducting cat qubits. This will involve new specifications to take into account :
  - Nitrogen supply management
  - Vibration and acoustic constraints
  - Electromagnetic field constraints, …

- Feedback from the integration of the first two quantum computers at TGCC :
  - The most difficult point was taking security into account with our level of requirements for an installation in operation at the CEA.
  - The second point of attention is a clear specification of all the needs and constraints for the operation and maintenance of these new quantum computers.

Thank you, questions ?