

FAULT TOLERANT QUANTUM COMPUTING CHALLENGES AND OUTLOOK

WORKSHOP

Forum
TERATEC 25

Introduction Catherine Lambert

*President of **CERFACS** and head of the FTQC Group of the Académie des Technologies, Member of the **Académie des Technologies***

Key points from the rapport of Académie des Technologies Olivier Ezratty

*Author and Quantum Engineer, **Quantum Energy Initiative***

Pannel chaired by Jean-Philippe Nominé, HPC Strategic Collaborations Manager, **CEA**

With the participation of :

- Anthony Leverrier, *Research, **Inria***
- Frédéric Magniez, *Directeur de recherche, Laboratoire IRIF **CNRS***
- Boris Bourdoncle, *secrétaire général du rapport, **Quandela***
- Mamdouh Abbara, *Client Engagement Specialist, **Alice & Bob***
- Cyril Allouche, *Head of Quantum Computing R&D, Head of Disruptive Innovation, **Eviden***

Conclusion & perspectives Loïc le Loarer

*coordinateur de la **Stratégie Nationale Quantique**, **SGPI**, Services du Premier Ministre*

Introduction

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CALCUL QUANTIQUE TOLÉRANT AUX FAUTES : DÉFIS ET PERSPECTIVES

Rapport de l'Académie des technologies

Catherine LAMBERT, Présidente du Cerfacs



Academy of technology report scope (*)

Quantum Computing Paradigms

Classical computers

quantum
inspired

quantum
emulators

Analog quantum computers

quantum
annealers

analog
quantum
simulators

Digital quantum computers

gate-based

NISQ (Noisy
Intermediate Scale
Quantum)

FTQC (Fault-
Tolerant Quantum
Computers) error
correction and
fault tolerance

Universal, Reliable and Scalable
Quantum Computer

An Industry inspired Working Group

Steering committee

- Catherine Lambert (Cerfacs President)
- Thierry Bonhomme (former Orange Business Service EVP)
- Gérard Roucairol (former Bull Research EVP)
- Boris Bourdoncle General secretary

- Frédéric Barbaresco
- Philippe Duluc
- Marko Erman
- Olivier Ezratty
- Philippe Grangier
- Daniel Kaplan
- Jean-Claude Lehmann
- Anthony Leverrier
- Frédéric Magniez
- Mazyar Mirrahimi
- Jean-Philippe Nominé
- Sophie Proust
- Claude Weisbuch

With the support of the French quantum ecosystem



Report main chapters

1. Quantum advantage and its needs
2. Error-correcting codes
3. Qubit technologies
4. Scalability
5. **Complementary elements:** economic analysis, competing technologies, benchmarking, HPC links, human capital, funding strategies.

Identified significant challenges

- **Scaling** qubits numbers and quality
- **Interconnecting** quantum processors
- **Algorithms** and software engineering
- **HPC** integration.
- **Benchmarking** methodology
- **Enabling** technologies
- **Competing classical technologies** progress (AI, silicon, ...)
- **Skills.**