

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

**DOTTORATO DI RICERCA / PHD PROGRAM IN  
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING**

## **Seminar announcement**

**Friday 17 January 2025, Time: 10:30 - 11:30**

**Room I.6, Building I, DIETI - Via Claudio, 21 - NAPOLI**



### **Prof. Paolo Rech**

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## **The Good, the Bad, and the Ugly in Quantum Computing: Computational Power, Intrinsic Noise, and Transient Faults**

**Abstract** Quantum computing is a new computational paradigm, expected to revolutionize the computing field in the next few years. Qubits, the atomic units of a quantum circuit, exploit the quantum physics properties to increase the parallelism and speed of computation. Unfortunately, qubits are both intrinsically noisy and highly susceptible to external sources of faults, such as ionizing radiation. The reported qubits error rate is so high that researchers are questioning the large-scale adoption of quantum computers and forces unpractical mitigation solutions such as installing the quantum computer in underground caves. Innovative solutions to improve the reliability of quantum applications are then highly necessary. In the talk, after providing all information and background needed to understand quantum computing basics and an

overview of the available quantum technologies vulnerabilities, we will present the available hardening solutions and the open challenges that need to be addressed. We will consider both the intrinsic noise, that has a predictable and incremental effect, and radiation-induced transient faults, that are stochastic and modify the qubit in an unpredictable way. Based on the latest studies and radiation experiments performed on real quantum machines, we will show how to model the transient faults in a qubit and how to inject this fault in a quantum circuit to track its propagation. We will discuss the vulnerability of qubits and of circuits, identifying the most critical parts and the main course for output corruption. Finally, we will provide an overview of the open (reliability) challenges in quantum computing to stimulate further studies and solutions.

**Lecturer short bio:** *Paolo Rech received his master and Ph.D. degrees from Padova University, Padova, Italy, in 2006 and 2009, respectively. He was then a Post Doc at LIRMM in Montpellier, France. Since 2022 Paolo is an associate professor at Università di Trento, in Italy and since 2012 he is an associate professor at UFRGS in Brazil. He is the 2019 Rosen Scholar Fellow at the Los Alamos National Laboratory, he received the 2020 impact in society award from the Rutherford Appleton Laboratory, UK. In 2020 Paolo was awarded the Marie Curie Fellowship at Politecnico di Torino, in Italy. His main research interests include the evaluation and mitigation of radiation-induced effects in autonomous vehicles for automotive applications and space exploration, in large-scale HPC centers, and quantum computers.*

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