Master in Photonics – "PHOTONICS BCN"
ERASMUS+ "EUROPHOTONICS"

MASTER THESIS PROPOSAL

Dates: April - September 2020

Laboratory: IFAE (Institut de Física d'Altes Energies)
Institution: Universitat Autònoma Barcelona
City, Country : Bellaterra (Barcelona) Spain

Title of the master thesis: Coherent control of a superconducting qubit

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Summary of the subject (maximum 1 page) :

We are approaching the age of quantum computers [1]. Throughout the world, many initiatives, both public and private, aspire to construct the first generation of quantum processors capable to surpass the computational power of the most powerful classical computers [2]. Among all candidate systems on which to build such a processor, superconducting quantum circuits [3] are among the most promising. These circuits behave as artifically engineered atomic systems in the microwave frequency domain, allowing their quantum state to be efficiently initialized, controlled, and read out [4].

In a collaboration between the High Energy Physics Institute (IFAE), the University of Barcelona (UB), and the Barcelona Supercomputing Center (BSC), we established a project to aim at building the first quantum processor in Barcelona using the technology of superconducting circuits. The construction of such system requires a multi-disciplinary effort of physics, electronics, material science and computer science.

In this project, the quantum state of a superconducting qubit will be manipulated using optimal control techniques designed to create superpositions, including the second excited state of the circuit, performing in this way qutrit quantum gates.

[1] *Quantum Computation and Quantum Information*, Nielsen and Chuang, Cambridge University Press (2000).
[2] https://www.sciencenews.org/article/quantum-computers-are-about-get-real

[3] *Superconducting Circuits for Quantum information: an outlook*. M. H. Devoret, R. J. Schoelkopf, Science 339, 1169 (2013).
[4] *Superconducting quantum circuits at the surface code threshold for fault tolerance*, R. Barends *et al*., Nature 508, 500 (2014).