



# FRANCESCO DI MARCANTONIO

PhD Student - Quantum Science Technology & Engineering Physics

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## BIOGRAPHICS

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## INTRODUCTION

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I am a PhD Student in Physics specialized in Quantum Science and Technology in the UPV/EHU University of the Basque Country, Spain. I have pursued my master studies in Engineering Physics, Quantum Technology track at KTH Royal Institute of Technology, Sweden, with a Master Thesis in Quantum Machine Learning achieved at CERN, Switzerland. I am a motivated student, passionate about Physics, and I strive for challenges. Learning is one of my biggest passions, including being amazed by the strangeness of Nature and its Laws. I hope to contribute to a healthy work environment where I can collaborate in synergy with my team. One of my biggest goals is to have an active role in the development of Quantum Computation and Quantum Machine Learning for the advancement of our understanding of Quantum Systems in the coming years.

## WORK EXPERIENCE

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**Doctoral Student in Physics** 01/2023 – Ongoing  
*UPV/EHU University of the Basque Country* *Bilbao, Spain*

The project will span a period of 3-4 years and will mainly focus on devising algorithms for the simulation of lattice gauge theories and quantum matter. Thus, the study will embrace the fields of Quantum Field Theory, and Quantum Science and Technology.

**Guest Student** 17/04/2023 – 19/05/2023  
*Max-Planck-Institut für Quantenoptik (MPQ)* *Garching, Germany*

The visit served as a starting point for a joint collaboration between MPQ and UPV/EHU on simulation of lattice gauge theories with tensor network methods. In particular, one of the goals of the project is to develop algorithms for the time evolution of the Z2 pure gauge theory. One interesting feature of the system is the observation of string deconfinement and its dynamics.

**Research Assistant in fiber coupling of Integrated Nanophotonic Circuits** 06/2021 – 08/2021  
*KTH Royal Institute of Technology* *Stockholm, Sweden*

My role was to study a mechanical technique to improve the **coupling** between lensed optical fibers and nanophotonic circuits. The advancement of nanophotonic circuits demands their integration into the available optical fiber network for communication and transport of information through photons. The dimensionality mismatch leads to losses. To fill this gap, I studied the effects of polishing on some **nanocircuits in Lithium Niobate** by machining it in the **Electrum Laboratory of Kista** and post-observation in the **NanoFab Lab of Albanova**. The study also included some measurements of the losses using multifrequency laser and multimeters.

## EDUCATION

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### KTH Royal Institute of Technology

08/2020 – 12/2022

*MSc in Engineering Physics, Quantum Technology track*

*Stockholm, Sweden*

The Master Programme covers the majority aspects of the emerging field of Quantum Technology. The characterizing courses are Advanced Quantum Mechanics, Quantum Technology (with lab experience and written production), Quantum Circuits, Quantum Photonics, Quantum Materials, Spintronics. A Physics theoretical background was given by the courses of Relativistic Quantum Physics and Quantum Field Theory.

### MSc Thesis at CERN:

01/2022 – 11/2022

*The Role of Data in Projected Quantum Kernels: the Higgs Boson Discrimination*

*Geneva, Switzerland*

Supervisor at CERN - Sofia Vallecorsa      Supervisor at KTH - Jens Bardarson

The Thesis focuses on Quantum Machine Learning. We study quantum kernels in a theoretical framework for assessing quantum advantage for the classification of an Higgs boson dataset. Additionally, we tested the novel technique of projected quantum kernel.

### Politecnico di Torino

10/2017 – 10/2020

*BSc in Engineering Physics - **Final Grade - 102/110***

*Torino, Italy*

Thesis: *In-Operando STM (High-Temperature Near-Ambient-Pressure STM)*

The Bachelor Degree in Engineering Physics combines and unifies the characteristics of a physicist and an engineer to create a professional figure in the advanced fields of Applied Physics.

## SKILLS

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- **Quantum Computing** Qiskit, PennyLane, QuTiP
- **Machine Learning** scikit-learn, Jax, Keras
- **Computational Physics** tensor networks, ground state search, time evolution, multiprocessing
- **Programming Language** Python
- **Scientific Language** L<sup>A</sup>T<sub>E</sub>X
- **Languages** Italian (mother tongue), English (C1), Spanish (B1), French (A2), Swedish (A1)
- **Soft Skills** cooperative, autonomous, clear communication and explanation, committed, scientific illustrations

## PUBLICATIONS

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### The Role of Data in Projected Quantum Kernels: The Higgs Boson Discrimination

12/2022

- The project consists of a **software** that facilitates classical and **quantum machine learning pipelines** for classification and regression tasks. The user can fetch the most widespread datasets and assess with theoretical metrics the existence of potential quantum advantage.

### QuASK: Quantum Advantage Seeker with Kernels | [CERN-IT-INNOVATION/QuASK](https://github.com/CERN-IT-INNOVATION/QuASK)

07/2022

- The work studies quantum kernels within a theoretical framework able to assess quantum advantage in supervised learning tasks. We leverage it for the classification of an Higgs boson dataset. Additionally, we tested the novel technique of projected quantum kernel.

## MERITS

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### Student travel stipend for International Conference QT4HEP22

01/11/2022 – 04/11/2022

*Recipient*

*Geneva, Switzerland*

- I was awarded of the student travel stipend for attending the International Conference on Quantum Technology for High-Energy Physics at CERN (Switzerland).

### Erasmus+ Internship Scholarship for Master's program

01/2022 – 07/2022

*Recipient*

*Stockholm, Sweden*

- I was awarded of the Erasmus+ Internship Scholarship for conducting my KTH Master's Thesis abroad, at CERN (Switzerland).

## COMPETITIONS

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### International Physics Tournament (IPT)

09/2021 – 05/2022

*Participant*

*Stockholm, Sweden*

- I participated in the **national selections** for Sweden. We developed a rigorous methodology to build an **electrostatic lighter** using piezoelectric effects and only materials available during **Bronze Age**. We won the national selection and arrived **7th in the semifinals** held in Colombia.

## PhD-Summer SCHOOLS, Conferences

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### School on Quantum Many-Body Phenomena out of Equilibrium

21/08/2023 – 01/09/2023

*ICTP*

*Trieste, Italy*

The school covers through theoretical lecture series and seminars fundamental concepts of non-equilibrium quantum many-body dynamics. The theory was balanced by talks on the cutting-edge advancements of the available experimental platforms (e.g. Rydberg atoms, etc.) Some of the key speakers are:

- **Dmitry Abanin** - Princeton University and Google
- **Jacopo De Nardis** - Cergy-Paris University
- **Norman Yao** - UC Berkeley
- **Paola Cappellaro** - Massachusetts Institute of Technology
- **Sebastian Diehl** - Institute for Theoretical Physics, University of Cologne
- **Simone Montangero** - University of Padua
- **Soonwon Choi** - Massachusetts Institute of Technology

### QTML22 International Conference

07/11/2022 – 12/11/2022

*University Federico II*

*Naples, Italy*

The event focuses on quantum machine learning (QML), an interdisciplinary field that bridges quantum technology and machine learning. The topics ranged from pure learning theory, and development of quantum algorithms to application of QML to chemistry, industry, finance and cybersecurity. Here you can find a non-comprehensive list of speakers:

- **Jacob Biamonte** - Skolkovo Institute of Science and Technology
- **Sankar Das Sarma** - University of Maryland
- **Gitta Kutyniok** - Ludwig Maximilian University of Munich
- **Seth Lloyd** - Massachusetts Institute of Technology
- **Hartmut Neven** - Google Quantum AI
- **Marcello Dalmonte** - International Centre for Theoretical Physics
- **Christa Zoufal** - IBM Zurich

The conference explores Quantum Technology in the context of High Energy Physics, featuring talks on quantum simulation (lattice gauge theories and neutrino physics), quantum computing (simulation of particle collisions), quantum sensing (dark matter detection), and quantum communication (data transferring from hep experiments). Speakers include experts from both academia and industry. A small list follows:

- **Joseph Lykken** - Fermilab Quantum Institute
- **Alessandro Roggero** - University of Trento
- **Piet Schmidt** - Institute for Experimental Quantum Metrology
- **Vedran Dunjko** - Leiden University
- **Giuseppe Carleo** - EPFL
- **Jay Gambetta** - IBM Quantum
- **Gian Giacomo Guerreschi** - Intel

The Lecture series covered the currently cutting-edge topics of Quantum Technology and Innovation Science:

- **Hiroshi Ishiguro** - Interactive robots and our future society
- **Toshio Yanagida** - A cyber world connecting the heart-to-heart created by brain information
- **Takuo Dome** - Aiming for a sustainable society rooted in sympathy from the viewpoint of economic
- **Masahiro Kitagawa** - Invitation to Quantum Computing
- **Takashi Mukaiyama** - Quantum Sensing
- **Keisuke Fuji** - Quantum Computing
- **Takashi Yamamoto** - Quantum Cryptography and Quantum Network
- **Kosuke Mitarai** - Quantum Information Science for Sustainable Development Goals

The summer school had six internationally renowned speakers who lectured on different topics of Quantum Technology:

- **Ivette Fuentes** - Relativistic Quantum Information and Metrology
- **Seth Lloyd** - Quantum sensing and Quantum Algorithms
- **John Martinis** - Quantum Computing with Superconducting Circuits
- **Shruti Puri** - Quantum Computing with Continuous Variables
- **Piet Schmidt** - Optical atomic clocks: basic principles and applications
- **Christine Silberhorn** - Photonic Quantum networks with Integrated Optics and pulsed light