

Progetto Laurea Magistrale Plus

(Students enrolled for the first time in the Academic Year 2024/25, undertaking the internship in the company in 2025/2026)

University info

Laurea degree: PHYSICS
University tutor / Thesis supervisor: Prof. Matteo Galli
Courses / Expertize of the university tutor: Integrated photonics for classical and quantum applications

Company info

Company name: CEA-Leti
Company Tutor(s): Emanuel Peinke, Benoit Charbonnier and Segolene Olivier
Role in the company of the tutor(s): R&D engineer in silicon photonics

Contents and info on project and internship

Project title: Development and experimental validation of optimization algorithms for programming silicon photonics integrated circuits for neural networks and quantum information
<u>Activity scenario and targets of the internship - Area/Department/office/lab (where the trainee will be involved):</u> Programmable photonic integrated circuits (PICs) are at the heart of many emerging field such as Lidars, Optical neural networks and quantum information. While the mathematical description of the integrated components is of no difficulty, accounting for fabrication tolerances and various crosstalks makes the description of the full circuit not feasible without adding in situ diagnosing ports, thus limiting the scaling of this technology. In order to overcome this difficulty, new numerical optimization and learning techniques allow from a given set of measurements to program the desired operation without prior knowledge of the exact description of each individual component. At CEA-LETI we fabricated and packaged PICs for quantum computing and neuromorphic AI. In this master thesis project, we propose to apply an optimization algorithm to those chips to demonstrate full and flexible programmability, and allow for realistic operation of the PIC with high fidelity despite fabrication imperfections. In a first phase, the candidate will familiarize him-/herself with the machine-learning algorithm made to optimize the calibration process. He/she will get used to the experimental setup and learn how to interface the control hardware. In a second phase, we expect the candidate to apply these methods on PICs fabricated at CEA-LETI for integrated photonics IA as well as for quantum information applications and to assess the fidelity of the circuit for key computing configurations.
<u>Background / Expertize of the student required for the internship:</u> Master studies including semiconductors, photonics and/or computer science and programming
<u>Potential thesis topics:</u> To be discussed, possible in principle
<u>Company location and place of work:</u> (Full address) CEA-Leti – Optics and Photonics Department – 17 rue des Martyrs – 38054 Grenoble - France
<u>Time length of the internship:</u> 10 months (4.5 months + 6 months separated by 1.5 month)
<u>Benefits provided by the company</u> (at least reimbursement of 500€ per month): Reimbursement of 700€ per month in Grenoble
<u>Specific company requests:</u> Strongly motivated students with good exam scores, team working and flexibility skills to work in a multi-disciplinary environment (photonic circuit design and optimization, pre-industrial clean room fabrication, optical characterization)
<u>Other comments:</u> The student will get a practical insight of the various theoretical and experimental aspects of integrated silicon photonics technology in one of the largest technological R&D institutes in Europe.