



Progetto Laurea Magistrale Plus

(realizzazione esperienza in azienda anno accademico 2026/27)

University details

Degree Course

PHYSICS

University tutor/Thesis supervisor - Area of expertise of the university tutor

Prof. Matteo Galli - Integrated photonics for classical and quantum applications

Company details

Company Name

CEA-Leti

Company Tutor and Function/Role of the Company Tutor

Charly Leblanc & Daivid Fowler/ R&D engineers in silicon photonics

Project content and information about the internship

Title of the internship project

Inverse-design of photonic frequency combs

Activities/objectives planned for the internship and area/department in which the intern will be placed

The recent but very fast development of artificial intelligence is pushing the electrical interconnections of data centers to their limits in terms of throughput, density, and power consumption. By replacing these electrical links with optical fibers and integrating all the functions necessary for the production of optical transceivers on a chip, silicon photonics represents a unique opportunity to increase the performance of these systems while limiting their energy consumption.

In particular, the integration of a laser light source within a photonic chip is an essential building block for the development of this technology. While current systems rely on the use of external lasers or butt-coupled laser chips, the heterogeneous manufacturing of microlasers directly on the photonic chip will be at the heart of future generations of data centers. This integration will notably enable ultra-fast and energy-efficient communications over very short-distance (inter-chip, intra-chip).

Dissipative Kerr soliton (DKS) frequency combs are compact and stable optical sources with applications in high-speed communications, metrology, and quantum technologies. However, their efficient generation requires precise control of dispersion and losses in optical cavities. Apodized Fabry-Perot (FP) cavities, formed by chirped Bragg gratings, offer great freedom for dispersion engineering, enabling high power per comb line.

Inverse design is a novel approach that directly optimizes photonic device geometries to achieve target performances using gradient-based algorithms (adjoint methods). This method has already proven effective for designing flat or arbitrarily shaped frequency combs.

Within our laboratory, which employs around forty people, you will be responsible for:

- Literature Review: Study inverse design methods applied to photonic microresonators, particularly for DKS combs.
- Modeling and Simulation: Implement simulation tools (Python, Lumerical FDTD) to study Kerr soliton generation in apodized FP cavities. Use adjoint methods to optimize the integrated dispersion and Bragg grating geometry to achieve DKS combs with target spectral profiles (flat, Gaussian, or custom).
- Design and Validation: Design an optimized apodized FP cavity to maximize power per comb line and minimize losses. Validate designs using FDTD simulations and stability analyses (via nonlinear dispersion relations).
- Fabrication Constraints: Adapt designs for compatibility with cleanroom processes (e.g., Si_3N_4 or silicon-on-insulator). Collaborate with the fabrication team to assess the feasibility of proposed structures.

Intern's requirements/skills

Master studies including semiconductors and photonics, programming skills in Python, strong mathematical background

Training courses offered by the company during the internship (specify whether training courses will be offered and, if so, the title and area in which the intern will be trained)

Potential scope and topic of thesis

To be discussed, possible in principle

Internship location

CEA-Leti – Optics and Photonics Department – 17 rue des Martyrs – 38054 Grenoble - France

Duration of the internship

4+6 months

Expense reimbursement - information to be obtained if the company has a policy different from the minimum (min £500/net - max £800/net) - indicate any other benefits (shuttle bus, canteen, guest accommodation, etc.)

Reimbursement of 1300€ per month in Grenoble + benefits

Specific requests from the company

Strongly motivated students with good exam scores, team working and flexibility skills to work in a multi-disciplinary environment.

Notes/to be reported

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.