

**Ph.D. in Information Technology  
Thesis Defense**

**June 23<sup>rd</sup>, 2025**

**At 11:00 a.m.**

**Sala Conferenze Emilio Gatti – Building 20**

**Gabriele CAVICCHIOLI – XXXVII Cycle**

**PROGRAMMABLE PHOTONIC CIRCUITS FOR ANALOG COMPUTING**

Supervisor: Prof. Andrea Ivano Melloni

**Abstract:**

In recent years we assisted to a large increase in the demand of computational resources in every aspect of science and engineering. The performance required to processors increase at such a pace that electronic circuits struggle to meet. This is particularly true for applications where high bandwidth and low latency are critical. In this situation the use of programmable photonic integrated circuits (PIC) are emerging as promising computational units. Thanks to light interference these circuit can perform ultra-fast linear operation. There are already several demonstration of photonic "processors" but their use is limited to the implementation of matrix-vector multiplication. For this reason, in this work, we investigate both theoretically and experimentally the use of recursive programmable PICs based on Mach-Zehnder Interferometers Meshes for solving inverse linear problems including solving linear systems of equations and performing matrix inversion.

During the discussion of this work we will also show that recursive PICs can act as programmable optical filters with largely tuneable spectral response and we will discuss the challenges in programming this class of circuits, presenting a data-driven controller, based on a Artificial Neural Network, which is able to counteract parasitic effect in real hardware such as thermal cross-talk to increase the accuracy of the PIC.

**PhD Committee**

Prof. Francesco Morichetti, **Politecnico di Milano**

Prof. Nikolaos Pleros, **Aristotle University of Thessaloniki**

Prof. Olav Solgaard, **Stanford University**