



**Ph.D. Program in Electronics, Computer Science and Electrical Engineering**

## **SEMINAR**

### **Advancements in laser sources for label-free imaging in optical microscopy**

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**Aula Seminari Magenta**

**Abstract:** The most popular imaging modality in optical microscopy relies on the fluorescence emission of external fluorophores to achieve a sharp imaging contrast. However, label-free imaging methods also exist, avoiding the use of chemical dyes or stains but relying on specific alterations of light characteristics for contrast formation. For instance, the analysis of how a sample modifies the polarization of the light can be exploited to realize images related to their intrinsic optical anisotropies, such as birefringence or dichroism. Therefore, the proper generation and structuring of light properties enable the implementation of novel microscopy schemes, aiming to probe the biological properties of samples in a more native and less perturbed state. In this regard, the advancement of light source technologies has and always has played a central role in the evolution of the optical microscope, being the illumination module one of its main stages. This talk deals with laser technologies developed for realizing advanced optical microscopy techniques. Mainly, the discussion focuses on polarization-based microscopy and the use of a tailored optical oscillator exploiting the Zeeman effect to generate polarization states dynamically. Finally, this talk will discuss the biological application of polarization-based label-free microscopy and the impact of the development of compact and performing optical setup in spreading label-free techniques.

**Bio:** **Fabio Callegari** received his Bachelor's (Bioengineering) and Master's (Electronic Engineering) degrees from the University of Pavia under the supervision of Prof. F. Pirzio at the Laser Source Laboratory. Under his supervision, he initially worked on a novel technique involving the generation of Raman lines in optical fibers to measure the duration of sub-nanosecond laser pulses. Then, he collaborated with Bright Aerospace srl, a Bright Solutions srl group spin-off company developing lasers for aerospace applications. Here, he worked on developing a high-energy pulsed laser source intended to be used as a laser transmitter of an atmospheric LiDAR. Later, he achieved his PhD degree in Physics while working at the Italian Institute of Technology (IIT) and University of Genoa in July 2023 under the supervision of Prof. A. Diaspro, Principal Investigator of the Nanoscopy&NIC group in IIT. The main target of his research was the development of tailored laser sources for label-free bioimaging applications. In particular, he has been focused on polarization-based microscopy methods and he developed a polarisation-resolved imaging method based on the light features of a Zeeman Laser. During his PhD, he also spent an abroad research stay at the Ultrafast Laser Physics group (ETH, Zurich) under the supervision of Dr. Chris Phillips, where he developed a new dual-comb laser oscillator for spectroscopy and microscopy applications.

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