



## Thesis Project Form

**Title (tentative):** Optical Fluorescence Microscopy with Novel Event-Based Camera

**Thesis advisor(s):** Massobrio Paolo, Giuseppe Vicidomini

**E-mail:** Paolo.Massobrio@unige.it

**Address:** Via All'Opera Pia, 13 - 16145 Genova

**Phone:** (+39) 010 33 52761

### Description

#### Motivation and application domain

Fluorescence optical microscopy is one of the most powerful imaging techniques for studying biological samples, such as living cells, under physiological conditions. It enables the dynamic observation of biological processes, including rapid events like the diffusion of small organelles within a cell. However, the ability to study fast biological processes is fundamentally limited by the temporal resolution of the microscope, which depends on several factors, including the frame rate of the camera used to acquire images.

A promising solution to overcome this limitation is the use of event-based cameras—a novel class of bio-inspired vision sensors. Unlike conventional cameras, which capture images at fixed frame rates, event-based cameras detect changes in brightness at the pixel level and output a continuous stream of asynchronous events. This unique sensing approach allows for extremely high temporal resolution while significantly reducing redundant data acquisition.

However, because event-based cameras do not produce standard intensity images, traditional image processing algorithms cannot be directly applied.

#### General objectives and main activities

The project will focus on integrating an event-based camera into an existing wide-field fluorescence optical microscope at IIT. The student will be responsible for setting up the system, acquiring the first experimental datasets, and developing strategies to reconstruct conventional intensity-based time-series images with the highest possible temporal resolution from the continuous stream of asynchronous events.

#### Training Objectives (technical/analytical tools, experimental methodologies)

1. Literature Review: Conduct a critical and in-depth analysis of scientific publications to understand the state of the art in applying event-based cameras to fluorescence optical microscopy.
2. Optical Knowledge: Acquire fundamental knowledge of optics to set up a basic wide-field fluorescence microscope equipped with a camera.
3. Image Reconstruction: Learn existing algorithms for reconstructing intensity-based images from event-based camera data.

**Place(s) where the thesis work will be carried out:** Centre for Human Technology, Istituto Italiano di Tecnologia, Great Campus (Vicidomini Lab)

### Additional information

**Pre-requisite abilities/skills:** Previous experience or knowledge in the following topics would be highly appreciated: (i) programming skills in Python; (ii) Basic knowledge in image analysis and reconstruction

**Maximum number of students: 1**