

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

**March 27<sup>th</sup>, 2026**

**At 3:00 p.m.**

**Room Alpha - Building 24**

**Lorenzo FINAZZI – XXXVIII Cycle**

**NOVEL AVALANCHE PHOTODIODES FOR QUANTUM AND SENSING INFRARED  
APPLICATIONS**

Supervisor: Prof. Alberto Tosi

**Abstract:**

Complementary metal-oxide-semiconductor (CMOS) is the most widely used, refined and cost-effective fabrication process. CMOS compatible semiconductors include silicon and germanium, and photodetectors made with this technology can detect photons up to 1.8  $\mu\text{m}$ . However, many applications such as environmental sensing and spectroscopy would benefit from detection of photons above 2  $\mu\text{m}$  wavelength. In recent years, the development of Germanium Tin (GeSn) alloy has attracted growing attention, thanks to its tunable bandgap and compatibility with standard CMOS processes. With enough Sn content, the compound can be exploited for detecting photons in Short-Wave InfraRed (SWIR) and Mid-InfraRed (MIR) ranges. This would provide CMOS process an absorptive material to extend absorption range beyond the germanium cut off. Despite this, GeSn epitaxy technology is still immature: this leads to defective material, which results in enhanced photodetector noise. This constrains the development of efficient single photon detectors based on this compound. Nowadays instead, state-of-the-art SPADs for SWIR range are based on III-V semiconductors, such as InGaAs/InP SPADs. Despite having good performance, their fabrication is not CMOS compatible and custom workflow must be exploited for their manufacturing, lacking the versatility of CMOS process abilities. For this reason, ad-hoc back-end fabrications can be advised in order to target specific performance increase, such as optical crosstalk reduction in SPADs arrays or enhancement of photon collection efficiency. Finally, many applications and measurements techniques take advantage of single photon detection in SWIR through InGaAs/InP SPADs. For instance, TimeCorrelated Single Photon Counting (TCSPC) aims at measuring faint signals as a function on time, allowing to extract time-related information from radiation. The versatility of such technique allows TCSPC to be implemented in a wide range of measurements, from integrated optics to biomedical sensing.

**PhD Committee**

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