

Infrared single photon LiDAR on a Si chip

Level: Master 1, Bac+4

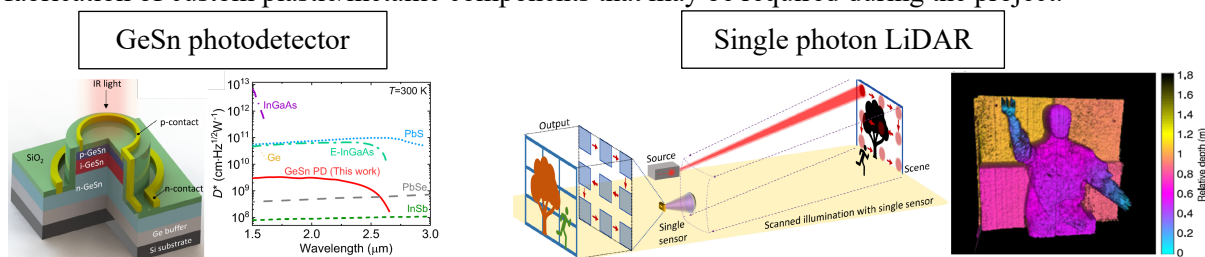
General Scope:

Direct band gap GeSn semiconductors enabled the monolithic integration of infrared light emitters and detectors on a Si photonics chip.¹ Over the past decade, GeSn photodetectors, lasers, and LEDs operating from short-wave infrared (SWIR: 1.5-3 μm) to mid-wave infrared (MWIR: 3-8 μm) have been demonstrated,²⁻⁴ and their use in practical technological applications at room temperature is now being explored. Developing GeSn classical and quantum photonics devices and their mass-scale integration in quantum sensing, industrial inspection, safety and security, environmental imaging, and automotive applications will be the primary technology roadmap for GeSn over the next decade.

Research topic and facilities available:

The goal of this internship is to integrate the SWIR/MWIR GeSn photodetectors developed at PHELIQS⁴ into imaging and quantum sensing technologies. The targeted application is the detection of infrared single photons and the demonstration of a benchtop LiDAR system.⁵ To this end, the single pixel GeSn detector is mounted on a remote-controlled X-Y stage to scan the scene and thus acquire the infrared image of an object. The student will design the electronic interface between the GeSn photodetector and the computer to acquire the 2D intensity map of the photocurrent signal and explore the data collection down to the single photon level. Post-processing image optimization using machine learning algorithm will be developed to improve image quality and combine multispectral datasets (*e.g.*, 2-3-4 μm sub-bands) into a single, enhanced hyperspectral image.

The student will have access to the optoelectronic lab at PHELIQS/SINAPS that is equipped with multiple FTIR setups for infrared absorption, photoluminescence, photocurrent, and imaging. With the support of a lab technician, the student could also utilize to the 3D printing and machining lab for the fabrication of custom plastic/metallic components that may be required during the project.



References (available on demand):

[¹] O. Moutanabbir *et al.*, Applied Physics Letters 118, 110502 (2021). [²] M.R.M. Atalla *et al.*, ACS Photonics 11 (2024). [³] M.-H. Chou *et al.*, Advanced Photonics Research 2400155 (2024). [⁴] T. Willoquet *et al.*, ACS Photonics 12 (2026). [⁵] R. Hadfield *et al.*, Optica 10 (2019).

Required skills:

Working in a team to perform collaborative experiments, background in solid-state physics, optics, and electronics, Python programming language.

Starting date and duration:

Fall/winter 2026 for 2-4 months.

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