Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

# MASTER INTERNSHIP POSITION

Proposé par : Emilien Peytavit
E-mail : Emilien.peytavit@iemn.fr
Numéro de Tel. : 0320197871
Groupe de Recherche : Photonique THz

## Modeling and design of linear photodiode arrays for RF and THz wave generation and detection.

**Context :** One of the most promising continuous-wave, room-temperature THz sources is based on the photodetection of the beat frequency generated by the spatial superposition of two infrared lasers. Photomixing involves a frequency conversion from the very high frequencies (~300 THz) of infrared lasers to lower frequencies, around 1 THz. This gives photomixing an intrinsically wideband character. Additionally, photomixing-based sources have the potential to be compact due to the use of laser diodes and semiconductor amplifiers, but they suffer from a lack of generated power, approximately 10 µW at 1 THz. The output power is limited by the trade-off between the small size of the photodetector (photodiode, photoconductor) to minimize its electrical capacitance and the photocurrent needed to generate high THz power. Photocurrent density is thus the key factor in improving output power. The best photomixers exhibit photocurrents reaching around 200 kA/cm², which is only ten times lower than those achieved in the best electronic devices, although they are not optically pumped. To overcome this intrinsic limitation, a solution involves arranging unitary components in a linear array to add the currents generated by each component in phase. This type of structure has been the subject of numerous studies (see for example reference [1]) in the past, as it also addresses the limitations of standard PIN photodiodes in terms of linearity, bandwidth, and saturation current for applications in optical telecommunications or in the generation of ultra-pure signals operating at wavelengths ranging from 780 to 1550 nm. Today, commercial photonic circuits allow such arrays to be illuminated with nearly 1:1 efficiency, paving the way for a new generation of ultra-fast photodetectors (electrical cutoff frequency >300 GHz) with very high saturation current (>50 mA).

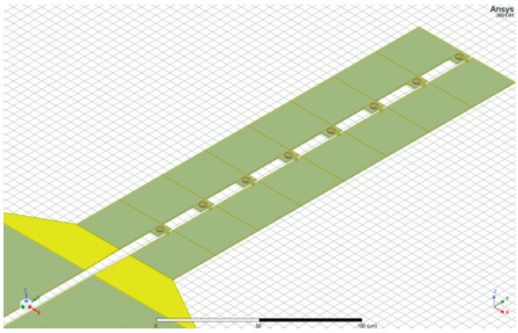


*Figure 1 : Example of a linear photodiode array. Electromagnetic modeling using the finite element method with Ansys HFSS software.*

**Tasks :** As part of this internship, this concept will be studied using transfer matrix methods to establish design rules for optimizing performance in terms of THz wave generation. 3D electromagnetic simulations using finite element methods (Ansys HFSS) or finite differences (Lumerical, CST) will then be used to design an array of 8 components, which will be fabricated and characterized up to 500 GHz on the microfabrication and optical & RF characterization platforms at IEMN. A multiphysics model combining optoelectronic device physics and electromagnetism may also be considered at a later stage

**Expected profile:** For this internship focused on optoelectronics and wave physics, we are looking for a student who has followed an academic path in Electrical Engineering (EEA) or Physics, with a strong background in RF/microwave, wave physics, and semiconductor physics, and who is motivated by research in applied physics.

**Career Opportunities offered by this internship :** The intern can then continue with a PhD or move towards the RF & microwave components and systems industry, which is currently highly promising.

**ATTENTION : TWO MONTHS DELAY BETWEEN APPLICATION AND INTERNSHIP STARTING (ZRR CLEARANCE DELAY)**

**Salary : ~600€/month. Duration : between 4 and 6 months Starting date : Mars 2026 (application deadline 1st January 2026)**

[1] L. Y. Lin *et al.*, "High-power high-speed photodetectors-design, analysis, and experimental demonstration," *IEEE Trans. Microw. Theory Tech.*, vol. 45, no. 8, pp. 1320–1331, 1997, doi: 10.1109/22.618430.