Thesis Title	Beam manipulation with optical-RF antenna arrays at THz frequencies for point-to-point communication applications	
Laboratories	IEMN & PhLAM	https://www.iemn.fr/ & http://www.phlam.univ-lille1.fr/
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Summary:

5G is expected to roll-out in a few years and is expected to introduce novel software and hardware solutions to integrate granular legacy and upcoming communication technologies within a single network architecture. Moreover, one of the key targets is to reach a ten-fold capacity increase with respect to 4G to improve the mobile broadband user experience or a lower latency to enable ultra-high reliable and robust communications for V2V applications for example. Two directions are currently considered to increase the capacity: adding spatial diversity (mandatory MIMO and optional massive MIMO) and new frequency bands. From this point of view, the 240 – 330 GHz frequency band is appealing due to the available bandwidth but key interdisciplinary technological issues at the frontier between optical and electronics (source and detection), signal processing, or even radio channel propagation must be individually and jointly tackled before mature commercial products reach the market. This scientific and technical expertise of these bricks has been emerging among the IEMN, PHLAM, and IRCICA laboratories with recent original results on the THz radio channel analysis as well as point-to-point indoor and outdoor communications.

The goal of this PhD thesis is to explore the feasibility of manipulating THz beams generated using multi-core photonics fibers and THz devices in arrays so as to multiplex information on several spatial channel (optical and THz) and go beyond the actual state-of-the-art. Such a project is then a good opportunity to transpose the current trend at the optical level (space-division multiplexing is a breakthrough technology for future optical communications) to the THz range. For instance, it aims at developing a comprehensive interdisciplinary framework between photonics and electronics to demonstrate beam steering/forming or multiplexing with optical-RF antenna arrays at THz frequencies for point-to-point communication applications with ultra high throughput, i.e. up to 100 Gbit/s capacity. The PhD student will work on MIMO signal processing aspects by building and validating first an optical-RF 2x2 MIMO communication chain. He will also study the feasibility and technological limits of dynamic beam steering/forming at the theoretical level with simulations. He will integrate and validate the optical (PhLAM) and electronics (IEMN) components. Finally, an optical-RF 7-antenna array setup will be developed and characterized in the lab to demonstrate the beam modifications and multiplexing capabilities. The PhD student will be co-advised by personnel from both the photonics (IRCICA: E. Andresen & L. Bigot) and electronics (IEMN: D. Gaillot & G. Ducournau) with the participation of 2 post-docs during the first year of the PhD program. Hence, the PhD thesis spans across the SMRE (Matter, radiation and environmental sciences) and SPI (Sciences for Engineering) doctoral schools.