



# PhD Offer

## Advanced Reconfigurable Antennas for 5G heterogeneous networks at millimeter waves

- **Key words**

5G, reconfigurable antennas, 60-GHz band

- **Context and overview of the problem**

To meet growing demand for higher throughputs in future 5<sup>th</sup> generation (5G) wireless systems, advanced digital communications techniques based on multicarrier modulations, multiple antenna systems (MIMO) and their extension to massive MIMO (M-MIMO), powerful coding schemes or interference coordination could be combined with solutions based on densification networks and deployment of heterogeneous infrastructures. An alternative but complementary way to increase throughputs is to deploy cellular systems operating in mmW bands, e.g. in V-band (57-66 GHz), and in E-band (71-76 GHz, 81-86 GHz). In such a context, M-MIMO systems, with dozens of radiating elements at the access point, are extremely attractive solutions to achieve very high data rates (multi-gigabit / sec) for multiple users sharing the same spectrum at the same time, with low power consumption thanks to the use of specific analogue/digital precoding techniques. Moreover, any effective hardware implementation of such systems must rely on a realistic knowledge of channel impairments and mmW propagation / antenna characteristics, especially for outdoor and mobile communications for which the data available in the most recent literature are very limited.

The proposed PhD thesis will be carried out in the frame of a collaborative research project (*M<sup>5</sup>HESTIA*) funded by Excellence Lab. *CominLabs* (<http://www.cominlabs.ueb.eu/fr/welcome-to-cominlabs>). The general objective of *M<sup>5</sup>HESTIA* is to design advanced M-MIMO antennas and characterize / model the outdoor mmW channel in order to demonstrate, a full M-MIMO hardware (HW) platform operating in the 60-GHz band. The main partners of *M<sup>5</sup>HESTIA* are IETR ([www.ietr.fr](http://www.ietr.fr)), LabSTICC (<http://www.lab-sticc.fr/>), Orange Labs ([www.orange.com/fr/Innovation](http://www.orange.com/fr/Innovation)), and IRT b-com ([www.b-com.com/](http://www.b-com.com/)).

- **Description of work**

The aim of this PhD project is to design, optimize, prototype and characterize advanced antenna architectures for future 5G networks in V-band. The thesis is organized into five main steps:

- Detailed bibliography study on 5G antennas, with emphasis on access point antenna solutions. The specifications of these antennas will be also defined.
- Study of a directive antenna system with steerable beam in one plane for outdoor channel sounding.
- Study of a low-gain antenna system for MISO (Multiple Input Single Output) communications.
- Study of a reconfigurable M-MIMO antenna system, with emphasis on the analog beamformer.
- Study and optimization of interconnection between antenna and active chips (amplifier, mixer, ...).

- **Candidate profile**

The PhD candidate should hold a Master degree M2R in electrical engineering (microwaves) or an equivalent title recognized by the doctoral school MATISSE (<http://matisse.ueb.eu/eng/>). In particular, he should master electromagnetic theory, microwave theory, antennas and circuit analysis. A good level of spoken and written English is required.

- **How to apply?**

Motivated candidate should send by email 1) a detailed CV, 2) a motivation letter, 3) a recommendation letter and 4) marks obtained over the last 3 years, to Ronan SAULEAU ([Ronan.Sauleau@univ-rennes1.fr](mailto:Ronan.Sauleau@univ-rennes1.fr)) and François GALLEE ([francois.gallee@telecom-bretagne.eu](mailto:francois.gallee@telecom-bretagne.eu)).

**Deadline to apply: May 31, 2016**