Ph.D. Position

Programmable electromagnetic (meta)surfaces at sub-THz frequencies

Spatiotemporal manipulation of the near- and far-electromagnetic (EM)-field distribution and its interaction with matter in the THz spectrum (0.1-0.6 THz) is of prime importance in the development of future communication, spectroscopy, imaging, holography, and sensing systems. Reconfigurable Intelligent (Meta)Surface (RIS) is a cutting-edge hybrid analogue/digital architecture capable of shaping and controlling the THz waves at the subwavelength scale. To democratize the RIS technology, it will be crucial to reduce its energy consumption by two orders of magnitude. However, the state-of-the-art does not address the integration, scalability, wideband, and high-efficiency requirements.

Based on our recent research results, the Ph.D. work aims to propose and experimentally demonstrate novel concepts and design methods for transmit- and reflect-RIS in the frequency range 100-300 GHz. The enhancement of the THz RIS performance will derive from a careful choice of the silicon technology and, from novel wideband meta-atom designs (also called unit cells) with integrated switches or Schottky diodes.

Breakthrough no. 1 Meta-atom designs using both silicon wafer substrates and low-loss laminates will be investigated to increase the degrees of freedom and improve the maximum achievable performance. Radio-frequency silicon-on-insulator (RF-SOI) CMOS technology with 45 nm will be considered, associated with the use of high-resistivity substrates (resistivity of about 7.5 kO×cm), which is expected to enable the integration, at affordable costs, of antenna elements and low loss MOS-based switches with Ron and Coff properties suitable for operation up to at least 300 GHz. Additionally, using this type of technology, local bias circuitry can be realized within each meta-atom. Therefore, each switch in each meta-atom can be individually controlled, offering unparalleled flexibility in the configuration of the RIS. Moreover, MOS-based switches lead to extremely low power consumption (in the order of tens of µW per meta-atom), as opposed to diodes (several mW per meta-atoms).

Breakthrough no. 2 A relatively fine phase resolution over the entire 360° range (e.g. a 3-bit uniform quantization) will be targeted, leveraging on the possibility to integrate several switches in each meta-atom. The successful demonstration of such a RIS would outperform state-of-the-art designs, which mostly rely on coarse phase quantization or do not cover the entire phase ranges.

Breakthrough no. 3 The possibility of dynamically controlling the amplitude of the transmission coefficients of the meta-atoms, besides their phase, will be also investigated. Near-field illumination will be introduced to obtain an ultra-low profile.

The PhD candidate will be hosted in the Antennas and Propagation group of CEA-Leti and will benefit from state-of-the-art CAD softwares, computing stations, RF equipments, and anechoic chambers. CEA-Leti is a world-leading research institute in silicon technologies with state-of-the-art clean room facilities and close links to industrial partners in the field. The thesis will be carried out in collaboration with the University of Rennes I (Prof. Ronan Sauleau). CEA and IETR (university of Rennes I) have a very strong and unique expertise on transmitarray antennas. The previous realized studies form 2006 demonstrated the potentiality of transmitarrays up to 330 GHz. The position is open to outstanding students with Master of Science, “école d'ingénieur”, or equivalent degree. The student must have a specialization in the field of microelectronics, photonics, microwave and/or electromagnetic waves.

Host Laboratory

CEA-LETI, Antennas and Propagation Laboratory, http://www.cea.fr/
Minatec Campus, 38000, Grenoble, France

Contacts

Dr. HDR Antonio Clemente
phone: +33-(0)4 38 78 56 87
e-mail: antonio.clemente@cea.fr
https://www.linkedin.com/in/antonio-clemente-44a668120/

Dr. HDR José Luis Gonzalez Jimenez
e-mail: loseluis.gonzalezjimenez@cea.fr

Prof. Ronan SAULEAU (IETR, University of Rennes 1, Rennes, France) will externally supervise the research work.