PhD Position 2018 (IETR, Rennes, France)

MILLIMETER-WAVE TECHNOLOGIES FOR BIOMEDICAL ELECTROMAGNETICS: MULTI-PHYSICS MICRODOSIMETRY

- **Key words**

  Multi-physics dosimetry, 1–100 GHz range, electromagnetic / thermal co-modeling, microscale characterization.

- **Context**

  Millimeter-wave (MMW) technologies are increasingly used for various applications. In particular, they have been used for high data rate communications [> 5 Gb/s], and 60-GHz technologies are expected to be integrated in the near future in the next generation mobile systems. Besides, it was suggested that MMW can be used for biomedical applications, including remote monitoring of wounds and non-invasive detection of glucose level. Recently, our research group has demonstrated the possibility of selective focusing of heating in cutaneous and sub-cutaneous layers by means of MMW. This paves the way to new potential applications of MMW in the field of biomedical electromagnetics, including selective targeting of skin cancers.

- **Objectives**

  The main purpose of this PhD project is to analyze electromagnetic (EM) field and temperature distributions at cellular level in order to gain an insight into local micro- and submm-scale phenomena occurring during exposure of the human body to MMW.

- **Work description**

  The PhD student will work at the Institute of Electronics and Telecommunications of Rennes (IETR), UMR CNRS 6164, Rennes, France. The guidelines of the PhD project are threefold:

  1. Micro-scale numerical EM and transient thermal analysis will be performed on cellular models of progressively increasing complexity. To this end, we will consider simplified geometric models of a single cell with sub-cellular organelles and will increase the complexity to realistic single- and multi-cell models. Various cell morphologies will be considered from nearly spherical to flat. This will result in definition of representative cell models.
  2. EM (complex permittivity and conductivity) and thermal (heat capacity and conduction) properties will be assigned to these models. This will involve characterization of effective EM and thermal properties of cells and cellular sub-structures (membrane components, cytoplasm, cellular organelles, etc.).
  3. The EM field distribution will be computed in the 1–100 GHz range using designed cellular models. Multi-parametric analysis will be performed to assess the variability of the EM field and power distributions as a function of geometry, complex permittivity, conductivity and micro-cellular environment. The data on micro-scale EM field and power deposition will be used as an input to thermal co-simulations.

- **Candidate**

  Education: MS or equivalent. *Background*: electromagnetics, numerical modeling, microwave / MMW / thermal measurements. Knowledge in biology / biophysics is welcome but not mandatory.

- **Contacts**

  To apply please send your CV, motivation letter, and reference letters (optional) before April 15, 2018 to:

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