PhD Position (2026-2029): Microwave metamaterial sensors for environmental health monitoring: from design to exposome integration, University of Bordeaux-IMS Laboratory (France),

PhD field: Electronics

Supervision & contact:

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Context & Motivation: air pollution is a major global health challenge, particularly for aging populations. Fine particles ($PM_{2.5}$) and volatile organic compounds (VOCs) are key contributors to oxidative stress and chronic diseases. However, current sensing technologies remain limited in terms of cost, selectivity, and long-term stability. This PhD project aims to develop next-generation microwave sensors based on metamaterials, within an exposome framework, to better understand the impact of environmental exposure on human health and aging. The project is aligned with the Sustainability Science Program of the University of Bordeaux.

Research Objectives: the main objective is to design and validate an innovative, compact, and selective microwave sensor capable of detecting atmospheric pollutants (VOCs and $PM_{2.5}$) with high sensitivity. Key objectives include:

- Understanding pollutant–sensor interactions through dielectric variations
- Identifying electromagnetic signatures of multiple pollutants
- Developing multi-pollutant detection strategies using Machine Learning
- Exploring links between environmental exposure and aging indicators

Methodology: the PhD will be structured around three main phases:

1. Design & Simulation: electromagnetic modeling of resonant structures (SRR, CSRR, fractal patch) in the X/Ku band (8-18 GHz), using HFSS, CST, and ADS.
2. Fabrication & Experimental validation: PCB prototyping with integration of functional polymers (HBPEI, polyimides), followed by S-parameter measurements (S_{11}/S_{21}) under controlled environmental conditions.
3. Environmental validation & Data analysis: comparison with reference data (Atmo Nouvelle-Aquitaine), construction of a library of electromagnetic signatures, and application of Machine Learning methods (PCA, PLS, SVM, Random Forest).

Innovation & Impact: this project combines microwave metamaterials, functional polymer chemistry, and advanced data analysis to develop low-cost, compact, and selective environmental sensors. It contributes to exposome research and opens perspectives for applications in environmental monitoring and health.

Environment & Collaborations: the PhD will be conducted at IMS Laboratory (Wave group), in collaboration with LCPO (functional polymers) and Gustave Eiffel University (data processing and Machine Learning). The work is connected to ongoing national and European research projects.

Candidate Profile: Background in electronics, RF, Sensing, or applied physics. Interest in sensor design, modeling, and experimental work. Knowledge in data analysis or Machine Learning is a plus. Motivation for interdisciplinary research is expected.

Salary: €2,300 gross/month, **starting** October 1, 2026. **Application deadline: May 15, 2026**

Required documents: CV (max. 2 pages), motivation letter, 1-2 recommendation letters, Master's degree certificate (or proof of completion), and transcripts for Master's years 1 and 2.