



**Microwave  
Components  
Group**  
Public University of Navarre

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Universidad Pública de Navarra  
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Smart Cities

**Reference: (ESR #3) PhD on New Design Techniques of Space Systems suitable for Additive Manufacturing in the context of Large Platforms / Marie Sklodowska-Curie Innovative Training Network H2020-MSCA-ITN-2018 on Advanced Technologies for Future European Satellite Applications (TESLA)**

**(A) General description of the PhD**

The Microwave Components Group (MCG) of the Electrical, Electronic and Communications Department at The Public University of Navarre (UPNA) is seeking to appoint excellent PhD students to join the Marie Sklodowska-Curie Innovative Training Network H2020-MSCA-ITN-2018 on Advanced Technologies for future European Satellite Applications (TESLA).

Space is a key asset for Europe. Europe's citizens enjoy the benefits, from jobs and economic growth, to public services, efficient communications and security provided by space systems. To respond to global challenges, Europe must continue to have a prominent role in space at a time when other world's powers are rapidly developing their space capabilities. Since satellite payload RF components and systems are essential for delivering mission objectives and supporting ground equipment and telecommunication systems, new technologies and techniques are required to respond to emerging satellite applications and technology challenges.

To this end, TESLA ITN will create a vibrant, multidisciplinary training-through-research environment uniquely equipped to develop the Advanced Technologies for Future European Satellite Applications. It will recruit, train and supervise 15 Early-Stage Researchers (ESRs), who will collaborate with senior staff in academic and industrial sectors to conduct top-notch research into new and enabling technologies for satellite flexible payloads, big constellation systems and Internet of Space, satellite high-speed communications and remote sensing, as well as large satellite platforms.

TESLA will also implement a unique cross-disciplinary and cross-sectorial training program, underpinned by the recent vision for Europe on open innovation, open science and open to the world, with the objectives to train the next generation of creative, entrepreneurial and innovative satellite communication developers, to provide all network ESRs broad training in transferable skills to enhance their career perspectives in both the academic and non-academic sectors, and to ensure that all network ESRs have the opportunity to complete a full PhD degree program. This will enhance the European space economy and business through the provision of highly skilled and mobile researchers. Moreover, young researchers will be involved in extensive public engagement and outreach activities for a wider economic and social impact.

Other universities join UPNA in this Marie Sklodowska-Curie Innovative Training Network H2020-MSCA-ITN-2018 on Advanced Technologies for future European Satellite Applications: Heriot-Watt University (UK) –coordinator-, Universitat Politècnica de València (ES), Christian-Albrechts-Universität zu Kiel (GE), Kungliga Tekniska Högskolan (SE), Technische Universität Graz (AT), Università Degli Studi di Perugia (IT), and Université de Limoges (FR). With the support of leading space companies and institutions such as TESAT, Spinner, Harp Technologies, SERMS, RFMicrotech, Joanneum Research, Lithoz, Airbus Defence and Space, VAL Space Consortium – ESA, Aurasat, and CTTC.

**(B) Specific objectives of the PhD**

The main objective of this Ph. D. Thesis is to develop new design techniques for passive components and subsystems for satellite applications, especially suitable for additive manufacturing fabrication in one single piece. The new design techniques will be based on Inverse Scattering synthesis and coupled-mode



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theory, and will produce passive components with smooth profile. The smooth profiles, implemented in rectangular waveguide technology, will be exploited to increase the power handling capability of the components, producing at the same time devices especially suitable for fabrication using metal additive manufacturing technologies such as SLM/DMLS. High-power, as well as SEY measurements, will be carried out to demonstrate the power handling capabilities of the components. Additionally, the Inverse Scattering synthesis techniques will be also employed to implement high-performance passive components in microstrip technology. These high-performance components will be based on the use of carefully-designed smooth-profiled ceramic substrates, obtained by additive manufacturing.

*I. Arnedo, M. Chudzik, J. M. Percas, I. Arregui, F. Teberio, D. Benito, T. Lopetegi, and Miguel A. G. Laso, "Synthesis of One Dimensional Electromagnetic Bandgap Structures with Fully Controlled Parameters", IEEE Transactions on Microwave Theory and Techniques, vol. 65, no. 9, pp. 3123- 3134, September 2017.*

*I. Arnedo, I. Arregui, A. Lujambio, M. Chudzik, M. A. G. Laso, and T. Lopetegi, "Synthesis of microwave filters by inverse scattering using a closed-form expression valid for rational frequency responses," IEEE Transactions on Microwave Theory and Techniques, vol. 60, no. 5, pp. 1244–1257, May 2012.*

*I. Arnedo, I. Arregui, M. Chudzik, F. Teberio, A. Lujambio, D. Benito, T. Lopetegi, and M. A. G. Laso, "Direct and Exact Synthesis: Controlling the Microwaves by Means of Synthesized Passive Components with Smooth Profiles," IEEE Microwave Magazine, vol. 16, no. 4, pp. 114-128, May 2015.*

*J. Hester, E. Nguyen, J. Tice, V. Radisic, "A Novel 3D-Printing-Enabled "Roller Coaster" Transmission Line", 2017 IEEE International Symposium on Antennas and Propagation, San Diego, CA, 2017, pp. 2639-2640.*

### **(C) Expected results of the PhD**

Several prototypes of passive components for satellite applications will be manufactured using metal additive manufacturing (for rectangular waveguide technology) and ceramic additive manufacturing (for microstrip technology). High-power characterizations will be carried out. The prototypes will fulfil advanced electrical specifications for satellite communications.

### **(D) Description of the host institution, UPNA**

The Public University of Navarra, [www.unavarra.es](http://www.unavarra.es), is located in the North of Spain with excellent connections with major cities in Spain and abroad. It is one of Spain's leading universities in terms of teaching, research and transfer (2017 ISSUE ranking, BBVA-IVIE). The university's commitment to teaching and the European Higher Education Area is shown by a wide offer of 22 Bachelor degrees (including 18 Bachelor degrees in foreign languages and 10 with specialization itineraries), 3 joint Bachelor degrees, 9 international programs, 26 Master degrees (5 of which permit access to regulated-by-law professions), 13 PhD programs and other 28 own titles and courses accredited by UPNA.

In its drive for competitiveness, UPNA has created 4 research institutes with more than 270 researchers: the Institute of Smart Cities (ISC), the Institute for Advanced Materials (InaMat), the Institute for Advanced Research in Business and Economics (Inarbe), and the Institute for Innovation and Sustainable Development in Food Chain (IS-Food). The university forms also part of Navarrabiomed (joint center with the Government of Navarra's Department of Health) and the Institute of Agrobiotechnology (joint center, alongside the Spanish National Research Council and the Government of Navarra).

UPNA is internationally well known by the quality of its research on telecommunications and, specifically, microwave engineering, where the PhD students have access to world-class laboratories and professors highly-ranked by external reviewers.

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#### (E) Planned secondments

The role is based at UPNA with secondments to other project partners in the EU. During the course of the PhD, the following short stays abroad are **tentatively** planned: TESAT Spacecom GmbH, Germany (around 2 months), Valencia Space Consortium/European Space Agency, Spain (around 1 month), University of Limoges, France (3 months). The student will also attend workshops and summer schools organized by other partners.