

# Job Description

PhD Candidates / Early Stage Researchers

Marie Skłodowska-Curie Innovative Training Network

**“Future Wireless Communications Empowered by Reconfigurable Intelligent Meta-Surfaces”**

The Department of Electronics and Nanoengineering of Aalto University, Espoo, Finland is seeking to appoint two high-calibre Early Stage Researchers (ESRs) to join the Marie Skłodowska-Curie Innovative Training Network on ‘Future Wireless Communications Empowered by Reconfigurable Intelligent Meta-Surfaces (MetaWireless)’.

<b>Positions:</b>	Early Stage Researcher <ul style="list-style-type: none"><li>- AALTO-1: Multi-function reconfigurable metasurface structures for wireless networks</li><li>- AALTO-2: Equivalent circuitual models of metasurface structures</li></ul>
<b>Location:</b>	Department of Electronics and Nanoengineering, Aalto University, Maarintie 8, Espoo, Finland
<b>Working Time:</b>	Full time
<b>Duration:</b>	Fixed term (3 years MSCA-ITN funding)
<b>Allowances:</b>	In agreement with the MSCA-ITN financial regulations ( <a href="http://ec.europa.eu/research/participants/data/ref/h2020/other/guides_for_applicants/h2020-guide-appl-msca-itn_en.pdf">http://ec.europa.eu/research/participants/data/ref/h2020/other/guides_for_applicants/h2020-guide-appl-msca-itn_en.pdf</a> ) (Section 5, page 27)

## About MetaWireless

Wireless connectivity has become a pillar of our society. The growth of wireless traffic is relentless, forecast to reach a staggering worldwide aggregate of 5,016 exabytes by 2030, along with bit rates of 1 Tb/s and new services related to sensing, localization, low-latency, and ultra-reliability. While the performance of wireless networks has improved phenomenally over the last decades, progress is by now pushing against fundamental limits and the mechanisms that have sustained these huge improvements are starting to falter. New evolutionary leaps are called for in order to ensure that the aforementioned forecasts can become a reality. To date, every wireless system has abided by the premise that the propagation radio channel is fixed by nature and cannot be tampered with, but only compensated through ever more sophisticated transmission/reception schemes. A potential evolutionary leap for 6G-and-beyond networks is to break free from the postulate that channels are uncontrollable factors. Serving such a vision, MetaWireless pursues the disruptive idea of designing wireless networks by treating the environment itself as a quantity to be controlled and optimized. Precisely, the manipulation of the wireless environment can be made possible by incorporating reconfigurable intelligent surfaces. These are planar structures, made of meta-materials and electromagnetically discontinuous, which do not adhere to conventional reflection and diffraction laws; rather, they can modify in a controllable fashion the phase and wavefront of impinging radio waves. If deployed to coat objects, walls, or building facades, they could allow customizing in real time the electromagnetic response of environments. Making this vision a reality requires the training of a new generation of researchers and a multidisciplinary effort involving wireless communications, physics, electromagnetic theory, and computational learning, which are the ingredients that define the MetaWireless project.

## The Role

AALTO-1 and AALTO-2 will be hosted by the Department of Electronics and Nanoengineering of Aalto University, which is located in Espoo, in the Helsinki metropolitan region. Both ESRs will be enrolled on the PhD programme of the School of Electrical Engineering of Aalto University, and will write their theses on a broadly defined topic related to *“Multi-function reconfigurable metasurface structures for wireless networks”*

(AALTO-1) and “*Equivalent circuital models of metasurface structures*” (AALTO-2). Early stage researchers will benefit, in addition, of a secondment period at other partners of the MetaWireless project.

Further information about the Ph.D. projects can be found in the following:

**Position:** AALTO-1

**Title:** Multi-function reconfigurable metasurface structures for wireless networks

**Scientific context:** Future adaptive and self-optimizing wireless networks require reconfigurable intelligent surfaces (RISs) with different functionalities, such as anomalous reflection, controllable diffuse scattering, absorption, single/multipoint focusing, polarization change. Also, these functionalities need to be reconfigurable (“intelligent windows”). The current state-of-the-art offers solutions only for some of these functionalities, and most of the known designs for advanced functional metasurfaces are not tunable. This ESR project is focused on developing new tunable metasurface solutions for unprecedented functionalities. In particular, solutions based on merging the concepts of metasurfaces and metagratings will be considered. The sparse structure of metagratings will simplify the external control of RIS while the versatile functionalities of metasurfaces will enable new functions. Also, planar versions of bianisotropic metasurfaces will be used to eliminate parasitic reflections from reconfigurable focusing and scattering artificial surfaces. Furthermore, the use of time-space modulated metasurfaces for creation of dynamically reconfigurable nonreciprocal metasurfaces will be considered.

**Objectives:** Identifying fundamental conditions under which RISs act as mirrors, diffusers, multi-beam absorbers or reflectors, both in the near and far field.

**Expected results:** Electromagnetic-based framework for synthesis and extracting the fundamental performance limits of RIS-based wireless networks.

**Acquire knowledge:** Electromagnetic tools for understanding and describing the interaction of electromagnetic waves with complex objects in the radio path.

**Planned secondment(s):** GreenWave (France) for 6 months.

**Position:** AALTO-2

**Title:** Equivalent circuital models of metasurface structures

**Scientific context:** At present, there exist no appropriate equivalent electromagnetic or circuital models for metasurfaces, which can be used in communication theory. This ESR project is focused on developing equivalent models of excitation and scattering from advanced reconfigurable intelligent surfaces (RISs), which will account for the properties (material, size, and inter-distance) of the unit cells, the angle of incidence and reflection/refraction of the radio waves, and the size and locations of the transmitter and receivers with respect to the RISs. The proposed approach consists of introducing equivalent macroscopic and mesoscopic surface impedances for the RISs under the assumption that their thickness is sufficiently small to be ignored in practice. This approach will unveil unknown relations between the appropriately averaged tangential electromagnetic fields at the two sides of the RIS, which will allow communication theorist to mathematically treat them as electromagnetic discontinuities in space. The objective is to develop simple, but accurate, equivalent reflection and transmission models for RISs, which will allow analytical estimation of scattered fields in near and far zones. These models will be suitable for development of generalized ray-tracing models and for optimization of wireless networks.

**Objectives:** To develop analytical frameworks for understanding scattering from advanced metasurfaces and for assessing their performance in large-scale wireless networks.

**Expected results:** New models of the behaviour of RISs and how they can be engineered to optimize the performance RIS-based networks. Analytical models based on diffraction theory generalizations for advanced metasurfaces.

**Acquire knowledge:** Theoretical knowledge allowing us to realistically model complex electrical structures with equivalent sheet models and diffraction theory.

**Planned secondment(s):** NOKIA (Finland), for 6 months.

Note: The two doctoral research projects are closely related, and there will be wide possibilities for collaborations between the two ESRs and more broadly in the Aalto research team and with the other partners of the ITN project.

## **Duties & Responsibilities**

1. Undertake postgraduate research and studies in support of the agreed doctoral research project, contribute to teaching of students.
2. Work closely with the academic supervisors to ensure the compatibility of the individual project with the overall goals of MetaWireless.
3. Present and publish research for both academic and non-academic audiences.
4. Attend and participate to academic and non-academic conferences, events and seminars.
5. Attend and participate to all training events and supervisory meetings.
6. Be seconded to other network partners as necessary to fulfil the grant obligations.
7. Prepare progress reports and other necessary documents for funding bodies, as required.
8. Contribute to the delivery and management of the wider programme, including attending and participating in programme committee meetings.
9. Actively contribute to the public engagement and outreach activities as described in the grant agreement.

As job descriptions cannot be exhaustive, the ESR may be required to undertake other duties (such as participation in teaching), which are broadly in line with the above duties and responsibilities.

## **Person Specification**

1. An undergraduate degree and a Master's degree (or equivalent) in electronic or electrical engineering, mathematics, electromagnetics, or a physical sciences subject.
2. Excellent mathematical skills and background.
3. High proficiency in Matlab, Mathematica, Maple, R, or similar programming software.
4. Solid background on electromagnetics, microwave engineering, wireless communications (especially antennas, propagation, diffraction theory).
5. Excellent written and verbal communication, including presentation skills.
6. Highly proficient English language skills.
7. Excellent organisational skills, attention to detail and the ability to meet deadlines.
8. Ability to think logically, create solutions and make informed decisions.
9. Willingness to work collaboratively in a research environment.
10. A strong commitment to his/her own continuous professional development.
11. Willingness to travel and work across Europe.

## **Eligibility Requirements**

All candidates must meet the following requirements to be considered for these posts:

- a) Early-Stage Researchers (ESRs) shall at the time of recruitment by the host organisation be in the first four years (full-time equivalent research experience) of their research careers and not yet have been awarded a doctoral degree. Full-time equivalent research experience is measured from the date when a researcher obtained the degree which would formally entitle him or her to embark on a doctorate, either in the country in which the degree was obtained or in the country in which the researcher is recruited.

At the time of recruitment by the host organisation, researchers must not have resided or carried out their main activity (work, studies, etc.) in the country of their host organisation for more than 12 months in the three years immediately prior to the recruitment date. Compulsory national service and/or short stays such as holidays are not taken into account.

## How to Apply

Applications must be submitted according to the following procedure:

- 1) Registration and submission of the application material to the MetaWireless recruitment website <https://h2020-msca-itn-metawireless.cnit.it/jobs/>;
- 2) Registration and submission of the application material to the AALTO recruitment website <http://www.aalto.fi/en/about/careers/jobs/view/3137/>.

Note 1: Registrations and submissions need to be done on both websites.

Note 2: By registering on either of the two websites mentioned above, the applicants agree that the members of the MetaWireless project can access their personal data and application material.

Each application must include the following material:

- a) A cover letter explaining the motivation for applying for the post.
- b) A curriculum vitae setting out the educational qualifications as well as any additional scientific achievements and publications.
- c) Evidence of English proficiency.
- d) Copy of Bachelor's and Master's certificates.
- e) Copy of Bachelor's and Master's transcripts.
- f) Any additional material useful for the assessment of the candidate (e.g., recommendation letters, research project in agreement with the requirements specified in the previous text).

## Selection Process

The selection and recruitment processes of the ESRs will be in accordance with the European Charter and Code of Conduct for the Recruitment of Researchers. The recruitment process will be open, transparent, impartial, equitable, and merit-based. There will be no overt/covert discrimination based on race, gender, sexual orientation, religion or belief, disability, or age. To this end, the following selection criteria for the recruitment of the ESRs will be considered:

- 1) Curriculum vitae
- 2) Academic performance (diplomas, university transcripts, etc.)
- 3) Research and industrial experience
- 4) Awards and fellowships
- 5) Publications and patents
- 6) Research, leadership, and creativity potential
- 7) English knowledge
- 8) Other relevant items based on the specific candidate

The recruitment process will adhere to the guidelines described in the Grant Agreement of the MetaWireless project. At the network's level, the recruitment will be coordinated by the Recruitment Committee of the project in order to guarantee gender- and sector-balance. At the Aalto University level, the recruitment will be coordinated by the host department (Department of Electronics and Nanoengineering). More precisely, the recruitment and selection of the ESRs will be executed by the Scientist-in-Charge of the MetaWireless project for Aalto (Prof. Sergei Tretyakov) and by at least another scientist of the research group. The entire process will be overseen and approved by the HR Coordinator and the Department Director.

The application deadline for both posts is on **10 April 2021**. Each application will be acknowledged electronically (e.g., by return email) and a unique ID number will be assigned to it. The applications will be analysed after the application deadline, and the shortlisted candidates will be invited to a teleconference interview. The selected candidates will be recruited no later than 30 November 2021. At the end of the selection process, all the applicants will be informed of the outcome of their application by return email. Applicants interested in joining the AALTO are invited to apply to both posts AALTO-1 and AALTO-2, and to express their preference for the most suitable post (if any).

## **Further Information**

For more information about the posts AALTO-1 and AALTO-2, please contact Prof. Sergei Tretyakov (firstname.lastname@aalto.fi). More information about the Aalto research team can be found at meta.aalto.fi. For Aalto recruitment process related questions, please contact HR Coordinator Annika Salmelin, firstname.lastname@aalto.fi.

## **About Aalto University**

Aalto University is a community of bold thinkers where science and art meet technology and business. We are committed to identifying and solving grand societal challenges and building an innovative future. Aalto University has been ranked the 9th best young university in the world (Top 50 under 50, QS 2018) and one of the world's top technology challenger universities (THE 2017), for its outside-the-box thinking on research collaboration, funding and innovation. Aalto has six schools with nearly 11 000 students and 4000 employees of whom close to 400 are professors. Our main campus is located in Espoo, capital area of Finland.

We believe that people from diverse backgrounds can together reach the best results. Diversity is part of who we are: for example, over 40% of our academic faculty comes from outside Finland. We warmly encourage qualified candidates from all backgrounds, especially minorities, to apply, as we want to ensure our community's diversity and inclusiveness in the future as well. We are committed to equal and transparent recruitment procedures.

At Aalto, high-quality research, art, education and entrepreneurship are promoted hand in hand. Disciplinary excellence is combined with multidisciplinary activities, engaging both students and the local innovation ecosystem. Our main campus is quickly transforming into an open collaboration hub that encourages encounters between students, researchers, industry, startups and other partners. Aalto University was founded in 2010 as three leading Finnish universities, Helsinki University of Technology, the Helsinki School of Economics and the University of Art and Design Helsinki, were merged to strengthen Finland's innovative capability.

## **Disclaimers**

By applying for this position, the applicants declare to fulfil the eligibility requirements defined by the MSCA and listed above.

By applying for this position, the applicants agree that they will comply with the secondment plan.

By applying for this position, the applicants agree that they will comply with the rules of the planned Ph.D. enrolment.