



# PhD in INGEGNERIA AEROSPAZIALE / AEROSPACE ENGINEERING - 40th cycle

**PNRR 630 Research Field: RADIO-FREQUENCY DATA ANALYTICS THROUGH ADVANCED DATA PROCESSING TECHNOLOGIES/ALGORITHMS**

Monthly net income of PhDscholarship (max 36 months)
<b>€ 1500.0</b>
In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
<p><b>Motivation and objectives of the research in this field</b></p>	<p>The capability of monitoring the Radio-frequency spectrum from space (referred to as 'Space-based RF sensing') is one of the emerging challenges in the context of space and earth surveillance applications. Traditionally, RF monitoring is carried out 'on-ground' with conventional techniques based on receivers and instruments designed to analyze the electromagnetic spectrum, to detect specific signals and/or interferences (intentional or not) and possibly to perform their geolocalization. Thanks to advanced mathematical models and signal/data exploitation algorithms, it is then possible to classify and identify the detected signals, e.g. based on their physical features such as - but not limited to - transmitted power, frequency band, modulation, etc. However, the main limitations of this implementation are related to local coverage, receiver front-end bandwidth, and the complexity of processing models. The space-based RF sensing, together with the advent of Software Defined Radio (SDR) technology, allows to overcome the coverage limitations of terrestrial systems and the limitation in bandwidth by ensuring a broader RF spectrum monitoring capability, as well as a high revisit time of the areas of interest. In this context, the development of innovative algorithms for the analysis of a large amount of data (big data) based on Machine Learning approaches is expected to significantly improve the processes of extracting knowledge from the signal/data collected from the</p>



	electromagnetic environment.
<p><b>Methods and techniques that will be developed and used to carry out the research</b></p>	<p>The central objective of this research project is to develop advanced methods and techniques to extract meaningful information from RF data acquired from on-board RF sensor(s), aimed at improving surveillance and safety. This is a relatively new concept, and it constitutes a frontier research area embracing a wide variety of possible industrial applications, not limited to the space domain. The techniques and algorithms to be investigated may be derived from heterogeneous contexts different from space, just as it will also be possible to extend their future application to alternative or complementary scenarios, including anomaly detection or predictive maintenance. It is, therefore, possible, thanks to the use of these advanced analysis methodologies, to expand the types of signals that can be detected and classified, as well as considerably progress in the decision-making processes, taking benefit of the correlation of RF Data Analytics and data available from other sensors and monitoring systems. In particular, the candidate will focus on the study of existing and advanced data processing and analytics methods applied to RF signals, for applications such as the detection of interfering signals, geolocalization of RF emitters through TDOA/FDOA algorithms, extraction of RF signal features, fingerprint or signature analysis of RF emitters, etc. The analysis will include the development of ad-hoc algorithms based on ML/AI for the applications of interest and implementation on specific use cases in the satellite domain. The research project also foresees the implementation of a software simulator and/or contributions to test-beds, for the generation of the datasets necessary for the training and the validation of the implemented algorithms.</p>
<p><b>Educational objectives</b></p>	<p>This study focuses on understanding the context of space and Earth surveillance and leveraging advanced RF signal processing techniques. This understanding lays the groundwork for training a skilled professional capable of effective engagement in an international context within this domain. To conduct this analysis practically, a comprehensive review of existing literature on strategies</p>



	<p>and methodologies is essential, thereby enhancing the candidate's scientific knowledge. This expertise will enable the researcher to tackle current space-related challenges, contributing to the advancement of the space sector. Throughout this process, the candidate will acquire in-depth knowledge spanning advanced RF data analytics (including the development of ML/AI methods), the improvement of knowledge about GNU radio and Software Defined Radio (SDR), the development of skills in advanced numerical methods, software engineering, programming languages such as Python, Matlab and Machine Learning/Deep Learning stack. Additionally, the candidate will develop soft skills encompassing report writing, effective literature search, preparation of progress meetings and presentation of research findings.</p>
<p><b>Job opportunities</b></p>	<p>In today's environment, driving innovative solutions for the effective and comprehensive utilization of space data has become a key priority for many organizations, including various companies, governmental agencies, and educational institutions. The candidate will have the opportunity to capitalize on this trend through research conducted in partnership with Thales Alenia Space Italia SpA, a leading company in space applications and Earth monitoring from space. This collaboration will provide the candidate with valuable expertise in the space sector and unique networking opportunities. To this end, the program is promoting industrial and academic excellence in the field, which will require the long-term support of experienced professionals.</p>
<p><b>Composition of the research group</b></p>	<p>0 Full Professors 2 Associated Professors 6 Assistant Professors 14 PhD Students</p>
<p><b>Name of the research directors</b></p>	<p>Prof. Pierluigi Di Lizia, Mauro Massari</p>

<b>Contacts</b>	
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Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	750.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	ThalesAlenia Space - Italia
By number of months at the company	12
Institution or company where the candidate will spend the period abroad (name and brief description)	ESA - ESTEC (NL)
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
<p>The PhD candidate will receive a desk, possibly through a hot-desking procedure, and a personal computer, if needed. Apart from the compulsory ones, the PhD candidate will have the opportunity to follow additional courses and receive economic support to attend summer schools and participate in conferences. There will be the possibility of paid teaching assistantship.</p>