2021

Annual report

cnit
consorzio nazionale
interuniversitario
per le telecomunicazioni

National Lab
RaSS
Radar and Surveillance Systems

Director's Introduction

This is our official edition of the Radar and Surveillance Systems (RaSS) Laboratory's annual report, namely the *2021 RaSS Annual Report*.

This annual report has been prepared with the aim of showcasing the research activities that have been conducted and the major results obtained during this financial year.

In general, despite the current economical situation due to Covid-19, 2021 has been a very positive year that has seen

- the relocation of the RaSS laboratory to a larger space with more than 600 sm
- a consolidation of the personnel at RaSS with one new permanent research position and two new temporary research positions
- 35 active projects been carried out
- 22 publications published
- 29 participating members in 37 conferences, workshops and specialist meetings
- RaSS personnel leading three NATO activities and participating in three additional NATO activities
- six project proposals granted that will see new projects starting at the very beginning of 2021

This report has been kept concise and simple in order to give a brief breath of what RaSS has been concentrating its effort on in the last year. For any additional information, please feel free to contact me at rass@cnit.it.

Sincerely,
Marco Martorella
Director of RaSS

cnit consorzio nazionale interuniversitario per le telecomunicazioni

National Lab RaSS Radar and Surveillance Systems

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THE RADAR AND SURVEILLANCE SYSTEMS LABORATORY IN A NUTSHELL

The Radar and Surveillance Systems (RaSS) is a National Laboratory of the National Interuniversity Consortium for Telecommunications (CNIT). CNIT is a no-profit consortium composed of 44 Research Units (38 Italian Universities, 7 Departments of the National Research Council-CNR) and 6 National Laboratories (https://www.cnit.it/en/).
The RaSS Lab was founded in 2010 with the purpose of creating a critical mass to face research challenges in the field of radar and applied electromagnetics. Today, RaSS counts 32 people among researchers, technical and administrative staff.

The RaSS Lab has participated in several national and international research projects (often as leader), funded by the Italian MoD (Ministry of defence), EDA (European Defence Agency), MIUR (Ministry of Education), MISE (Ministry of Economic Development), EU FP7, EU H2020, ESA (European Space Agency), EOARD (European Office of Aerospace Research and Development), NATO SPS (Science for Peace and Security), NCIA (NATO Communications and Intelligence Agency), ARMASUISSE, ASI (Italian Space Agency), Tuscany Region, Industries like LEONARDO, MBDA, VITROCISET, INTERMARINE, GEM, E-GEOS, TELEDYNE, among others.

RaSS strives to maintain, and when possible to increase, the quality and excellence of the research activities and the results achieved.

At the same time, it seeks to strengthen and consolidate its structure and to invest in basic research in new promising areas.
RaSS places itself between academia and industry with the aim to fill the gap existing between them. Many research projects that have been carried out at RaSS have led to the development of fully integrated demonstrators with TRLs between 5 and 6.
RaSS also focuses its effort on dissemination activities, including journal and book publications, presentations at international conferences, training activities under the form of short courses, tutorials, seminars and lectures for industry, government and various research institutions.
RaSS values all its collaborations nationally and internationally, counting today more than 50 partners across, industry, academia and both government and non-government research institutions.
RaSS has a strong participation in both the NATO and the European Defence Agency (EDA) contexts, where its personnel hold key roles within Panels and CapTechs.
RaSS has also spun off two companies, namely ECHOES and FREESPACE. The former focuses on the design and development of radar systems whereas the latter deals with the design and production of advanced antenna concepts and electromagnetic compatibility. Both ECHOES AND FREESPACE improve the ability of RaSS to produce effective technological transfer.
RaSS holds today a key role in representing national and international expertise in the area of radar and electromagnetics with specific applications to surveillance systems.

FINANCIAL STATS

The RaSS Laboratory research funds come from various sources, including Government and Industry.

The following figures outline the number of active research projects and the financial trend from FY 2017 through FY 2021.

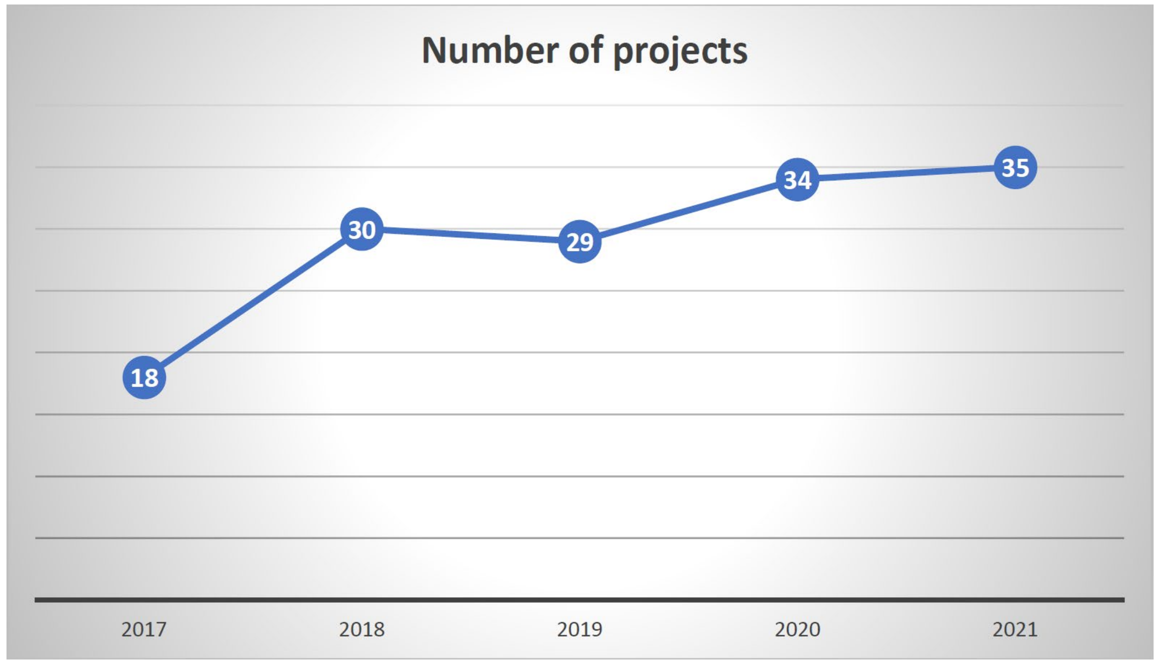


Figure 1 - RaSS Lab number of projects - FY 2017 through FY 2021

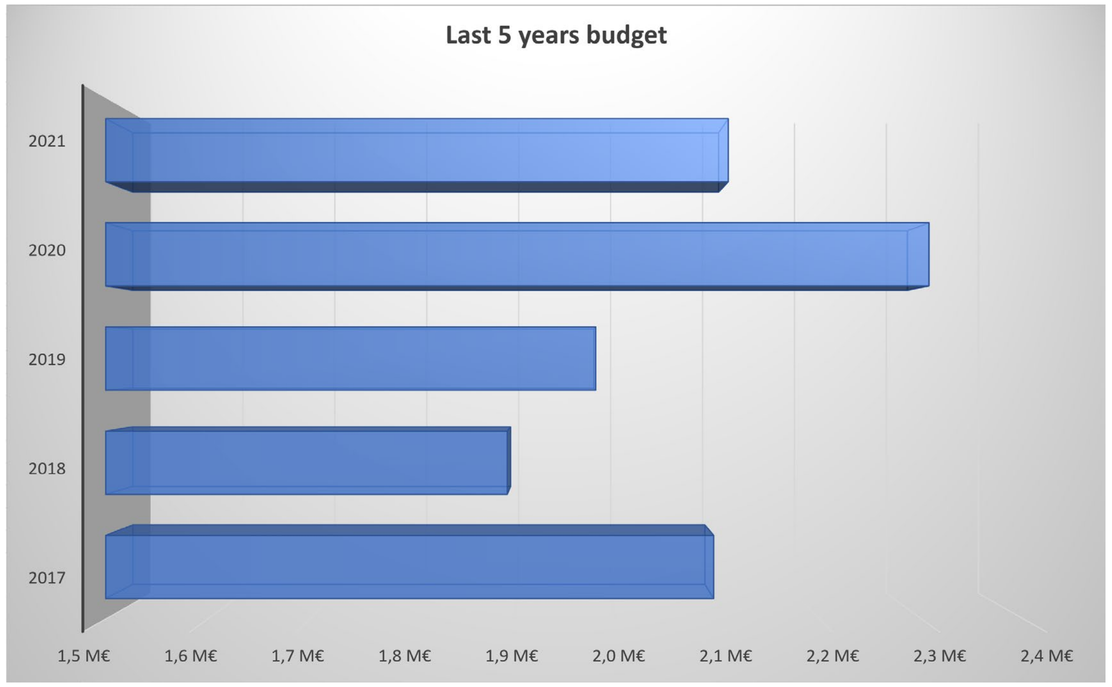


Figure 2 - RaSS Lab financial trend - FY 2017 through FY 2021

ORGANISATION CHART

Figure 2 shows the organisational chart of the RaSS Lab as on 31 December 2021.
This diagram illustrates the structure of the organisation and the relationships of its governing bodies and positions.
The RaSS Lab is organized in five research areas, namely radar systems, radar signal/image processing, remote sensing, antenna, electromagnetic modelling & materials. RaSS also has an explorative research area, where promising basic research is internally funded, an instrumental laboratory and a security office to handle classified information. On the administration side, RaSS is composed of a secretariat office, a quality control office and a public relation office. RaSS governance is directed by the Steering Committee, which is chaired by the Director.

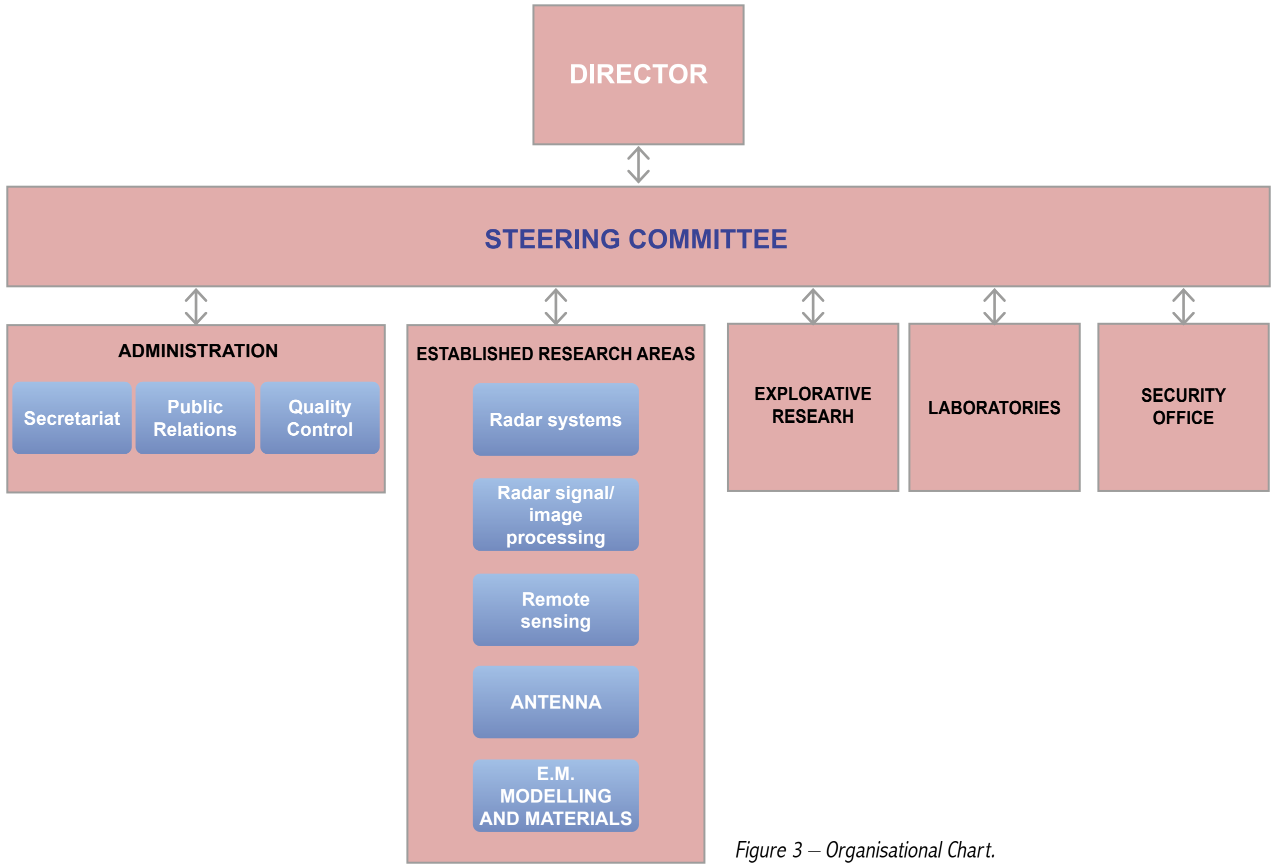


Figure 3 – Organisational Chart.

DIRECTOR

Prof. **Marco Martorella** received his Laurea degree (Bachelor+Masters) in Telecommunication Engineering in 1999 (cum laude) and his PhD in Remote Sensing in 2003, both at the University of Pisa. He is now an Associate Professor at the Department of Information Engineering of the University of Pisa and an external Professor at the University of Cape Town where he lectures within the Masters in Radar and Electronic Defence. Prof. Martorella is also Director of the CNIT's National Radar and Surveillance Systems Laboratory. He is author of more than 250 international journal and conference papers, 3 books and 19 book chapters. He has presented several tutorials at international radar conferences, has lectured at NATO Lecture Series and organised international journal special issues on radar imaging topics.

He is a member of the IEEE AES Radar Systems Panel, a member of the NATO SET Panel, where he sits as Chair of the Radio Frequency Technology Focus Group, and a member of the EDA Radar Captech. He has chaired several NATO research activities, including three Research Task Groups, one Exploratory Team and two Specialist Meetings. He has been recipient of the 2008 Italy-Australia Award for young researchers, the 2010 Best Reviewer for the IEEE GRSL, the IEEE 2013 Fred Nathanson Memorial Radar Award, the 2016 Outstanding Information Research Foundation Book publication award for the book Radar Imaging for Maritime Observation and three NATO Set Panel Excellence Award (2017, 2018 and 2021). He is a co-founder of ECHOES, a radar systems-related spin-off company. His research interests are mainly in the field of radar, with specific focus on radar imaging, multichannel radar and space situational awareness. He is a Fellow of the IEEE.

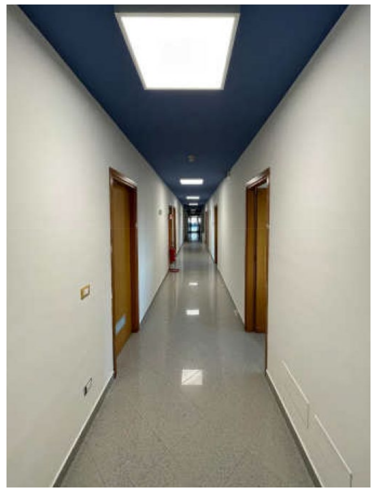
RASS LABORATORY NEW AREA

In response to an increased number of research activities and relative increase of personnel, and to allow for further expansions, in December 2021, the RaSS National Laboratory of CNIT has moved to a new area that occupies the entire 6th floor of one of the two main buildings in Galleria Gerace, Pisa, with more than 600 sqm of office and laboratory space.
The new space includes three separate laboratories, namely the Radar lab, the Microwave lab and the Quantum Radar Technology lab and two meeting rooms (one of which can seat comfortably more than 20 people) that can be reconfigured to accommodate both meeting and lecture theatre formats.
We are very excited to work in our new laboratory space and welcome you to visit us soon.

(a) External View

(b) Hall

(c) North Wing



(d) South Wing

(e) Director Office

(f) Meeting Room

(g) Panoramic View

Active Projects

PROJECT ANTI-DRONES

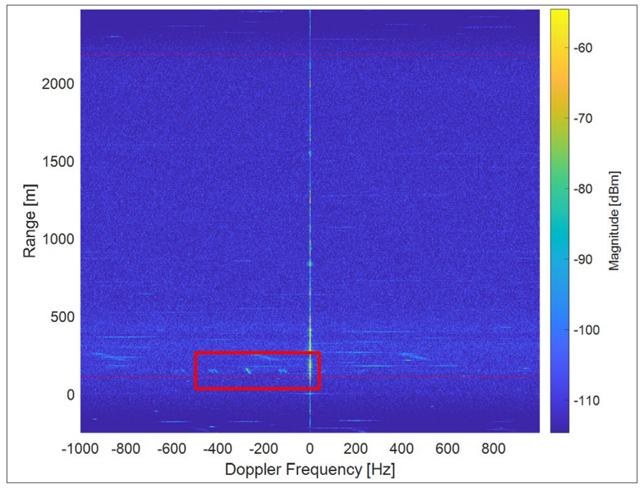
Innovative concept to detect, recognize and track “killer-drones”

The project focuses on the development of a new concept of anti-drone system, which able to detect, recognize and track killer-drones – mini/micro UAVs - in order to facilitate their neutralization and, at the same time, to minimise risks for people and assets. The realization of Anti-Drones’ goal requires the integration of different competences, such as system design and integration, design of antennas and transceiver, development of advanced signal processing algorithms, as well as development of software and firmware. The system is based on the use of software defined technologies and software engineering techniques to guarantee flexibility and re-use of existing technology.

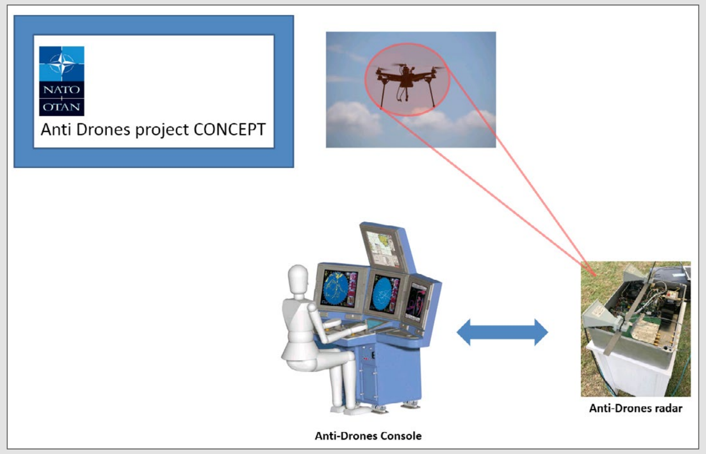
Anti-drones will move forward the current state of the art of anti-drone systems through the use of mini-radar technology and signal processing, which will improve current system performances with minimal environmental impact (e.g. visual impact and EM pollution) to the urban environment.

The Anti-Drone’s radar demonstrator has been tested during the measurement campaigns. The radar capabilities has been successfully verified through the detection of three different drones: DJI Spark, Sigma ingegneria HELIX, Sigma ingegneria horus (https://www.sigmaingegneria.com/robotica.php).

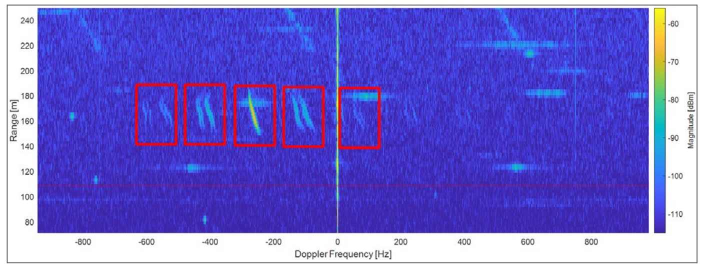
Technical Sheet
Funding institution:
NATO – ESCD – SPS Programme
Project partners
CNIT-RASS, Mother Teresa University (MTU), North Kazakhstan State University (NKSU)
Project duration
September 2019 - March 2023
Involved countries
Italy, North Macedonia, Kazakhstan



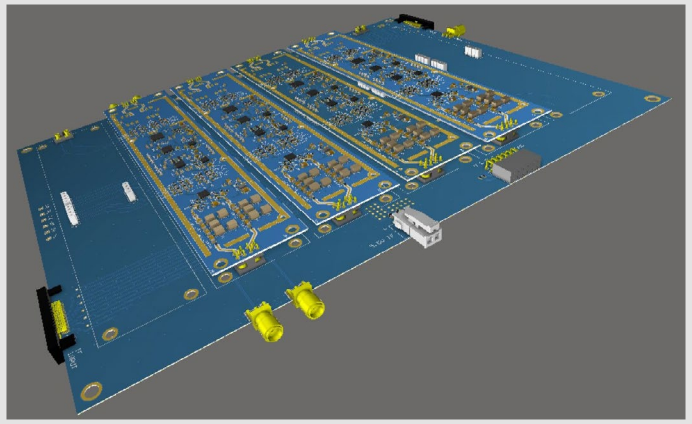
(c) Range Doppler map of a DJI Spark drone (weight 249g)



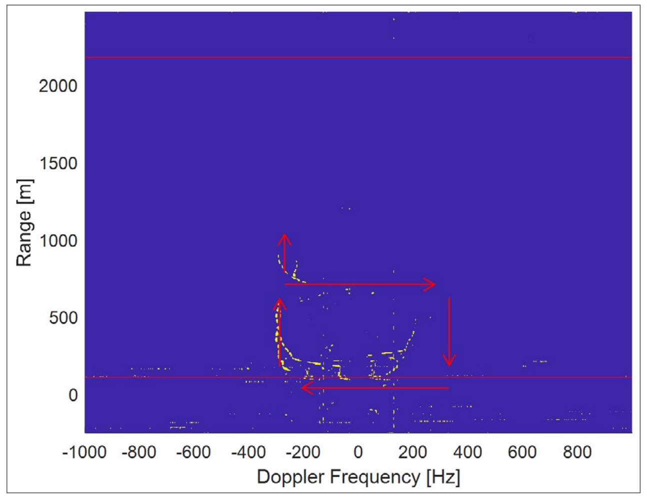
(a) - Anti-Drones project Conceptual Diagram



(d) Range Doppler map: detail of the blades signature



(b) 3D View of the IF board



(e) Range Doppler map: target trajectory

PROJECT ARIMOTA

Airborne Radar Imaging of Moving Targets

The surveillance of land and sea segments from airborne platforms both "manned" and "unmanned" is of fundamental interest both in civil and military applications. In particular, both in the Mediterranean region and in the state of Singapore, airborne sensors that can monitor large areas with controllable and flexible missions, can be seen as a viable solution. The ARIMOTA project is the result of a bilateral research collaboration that has been established between the Italian (MoD) and the Singaporean (MInDef) ministries of defence.

The aim of ARIMOTA is to study and develop airborne Multi-channel Synthetic Aperture Radar (M-SAR) for imaging of ground and maritime targets that are embedded in strong clutter. More specifically:

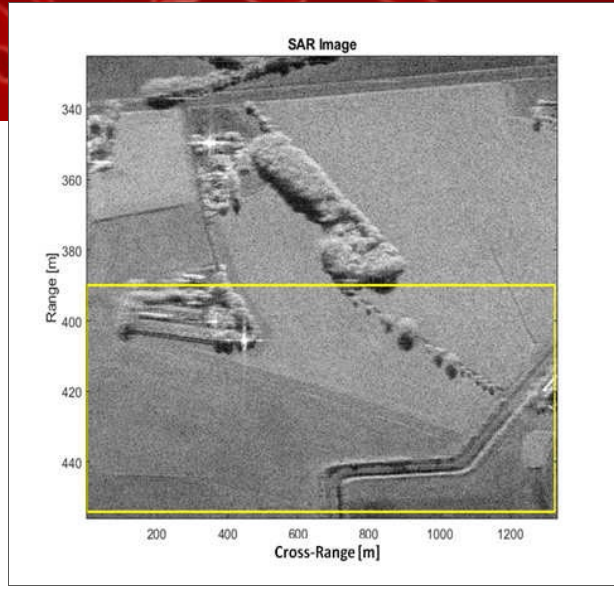
- Develop signal processing algorithms for an airborne SAR system with high performance in non-cooperative moving targets detection and imaging.
- Development of multichannel radar system demonstrator for airborne platform.
- Organization and conduct of trials for the acquisition of multichannel airborne radar data on both terrestrial and maritime scenarios.
- Data analysis for system validation.

The proposed activity matches the national needs for a complete airborne monitoring system. The system will be developed to interface with various airborne platforms. The demonstrator of the system will be developed and constructed with the criteria of low emission, compact and light in order to be used in a high number of types of missions and scenarios. The algorithms that will be developed and tested with the technological demonstrator will go in the direction of increasing the capabilities of intelligence in the military environment and of homeland security.

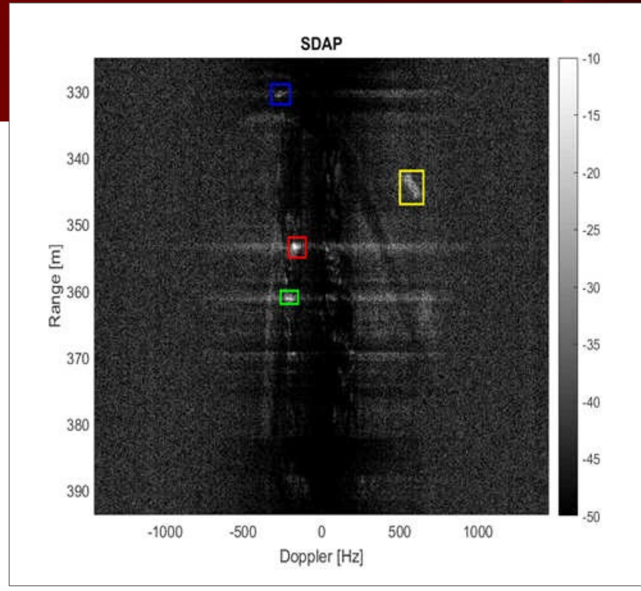
[1] Martorella M, Gelli S and Bacci A (2021). "Ground moving target imaging via SDAP-ISAR processing: Review and new trends" Sensors. 21(7) ISSN: [DOI] [URL]

Technical Sheet
Funding institution:
Italian Ministry of Defence (MoD)
Project partners
NANYAGH Technological University (NTU)
Project duration
November 2017 – November 2020
Involved countries
Italy, Singapore

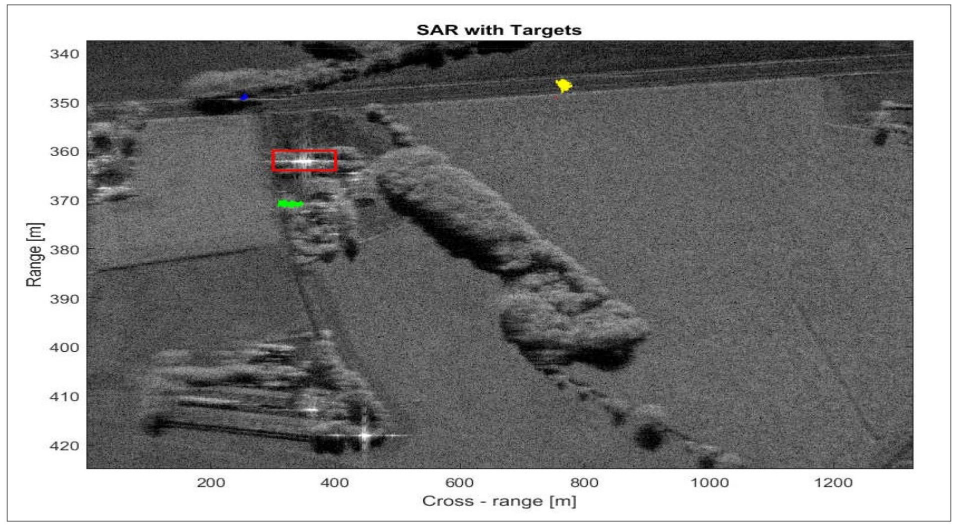
(a) SAR image of the area of interest [1]



(b) SAR image before STAP process applied to acquired data [1]



SAR image after STAP processing. As it is possible to see ground clutter is suppressed and some moving targets can be detected [1]



(d) SAR image in which detected moving target are superimposed after image refocusing [1]

(e) ARIMOTA multichannel SAR system (6 channels) and SmartBay communication system

(f) View of fiberglass pod containing the system

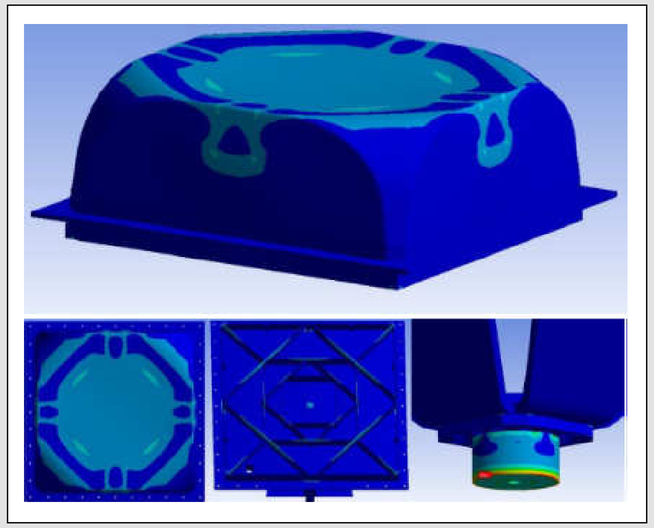
PROJECT CAPPA

Design, engineering, production and supply of V/UHF communication antennas for Italian Navy Ships PPA (Pattugliatore Polivalente d'Altura), Paolo Thaon Revel Class.
The subsystem is made of two kinds of innovative "conformal" antennas originally developed by CNIT/RASS withinthe SHIRED project, funded by Italian Ministry of Defence:

- a low-profile omnidirectional monopole mounted on flat metallic surfaces (decks)
- a distributed conformal array flash mounted on deckhouse walls.

The first agreement was about the supply of antenna systems for the first three PPAs, as part of the 2014 Naval Law. In late 2020 the contract has been renewed for the last four financed vessels.

Technical Sheet
Funding institution:
Leonardo SpA
Project partners
Free Space Srl
Project duration
January 2016 - April 2022
Involved countries
Italy



(a) Antenna Design using electromagnetic and mechanical simulation software;

(b) Antenna Qualification in Open Site at Italian Navy CSSN ITE laboratory;

(c) View of the Paolo Thaon Revel (P430) vessel with CNIT installed antennas during test;

(d) View of the Francesco Morosini (P431) vessel

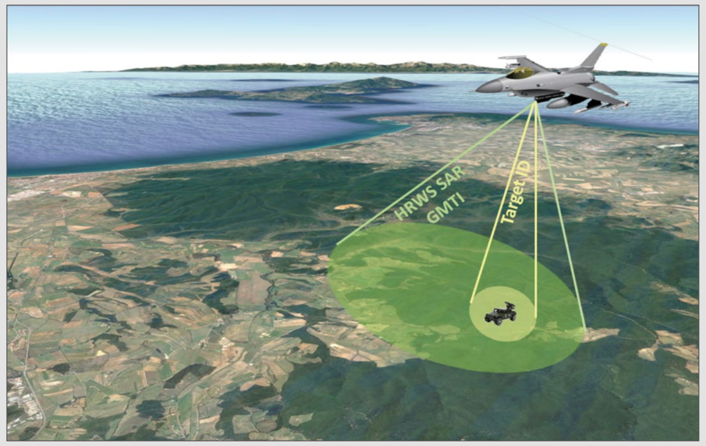
PROJECT COGITO

Cognitive radar for enhanced target recognition

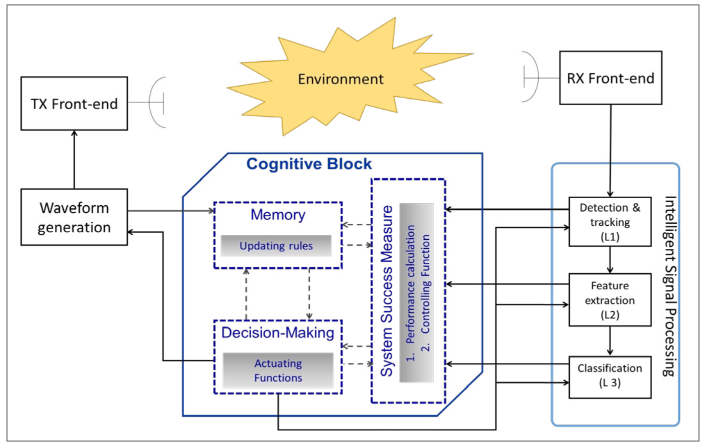
The COGITO project represents one of the first attempts to apply a cognitive architecture to the problem of target recognition. Today, in fact, most of the "Cognitive Radar" architectures, either implemented or under study, are focused on the radar capability to automatically select the regions of the frequency spectrum that are free of either intentional or unintentional radio frequency interferences. It should be noticed that such a way of working resembles that of a cognitive radio system more than a cognitive radar system.
The concept of cognitive radar for target recognition is based on the system's ability to understand the environment and to autonomously manage the radar system degrees of freedom (transmitted waveform and received signal processing parameters) as well as the target recognition algorithms.
A cognitive radar that is specifically designed for automatic target recognition will aim at maximizing target recognition performances by exploiting a priori knowledge of the external environment as well as by learning from its successes and failures.
The aim of this project is to develop and test, both on simulated and real radar data, different cognitive radar architectures for automatic target recognition. The project will also provide a performance comparison between classical HRR/ISAR classifiers and the newly developed cognitive architectures. In order of appearance, the images below show an implementation of the COGITO system concept in an operative scenario, the overall system architecture, a more detailed classifier block diagram, where the feedbacks toward the system intelligence are highlighted with different colours, and preliminary results obtained by using a dataset composed of e.m. target models of 4 cars. Results are provided in terms of accuracy, error and precision and are meant to compare the advantage of using cognition when the external environment changes. In the example provided in Fig. 4, the environment changes in terms of SNR. In this case, the system adapts to the environment changes by applying the on-line learning approach proposed in the COGITO project. Other scenarios have been simulated to prove the classifier capability to drive the transmitter parameters (bandwidth, number of receiving spatial channels and full-pol acquisition).

[2] Martorella M, Gelli S and Bacci A (2021). "Ground moving target imaging via SDAP-ISAR processing: Review and new trends" Sensors. 21(7) ISSN: [DOI] [URL]

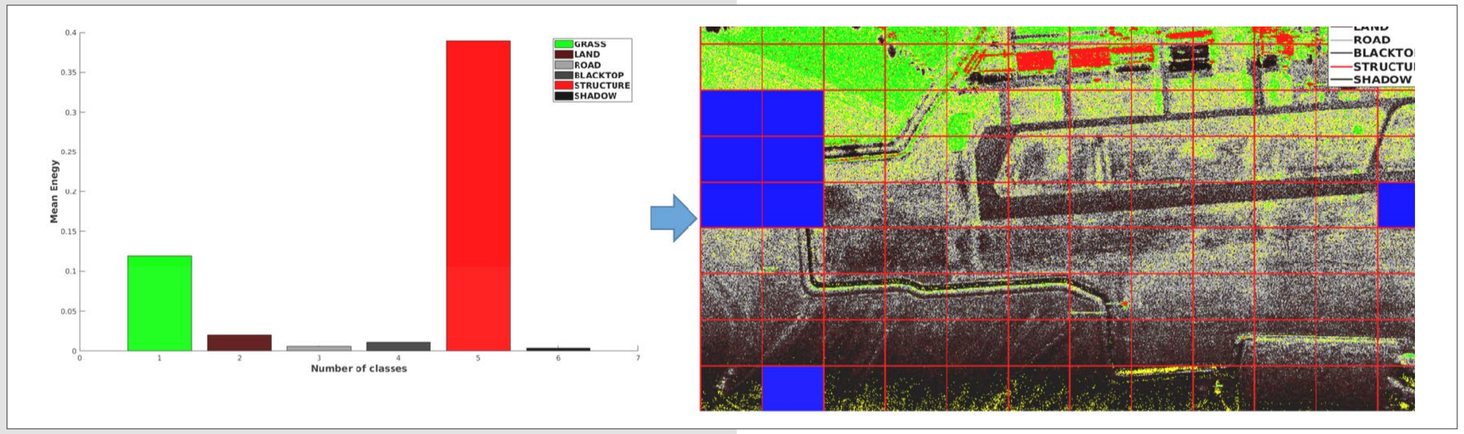
Technical Sheet
Funding institution:
European Defence Agency (EDA)
Project partners
IDS, FHR, MBDA
Project duration
January 2019 - January 2022
Involved countries
Italy, Germany



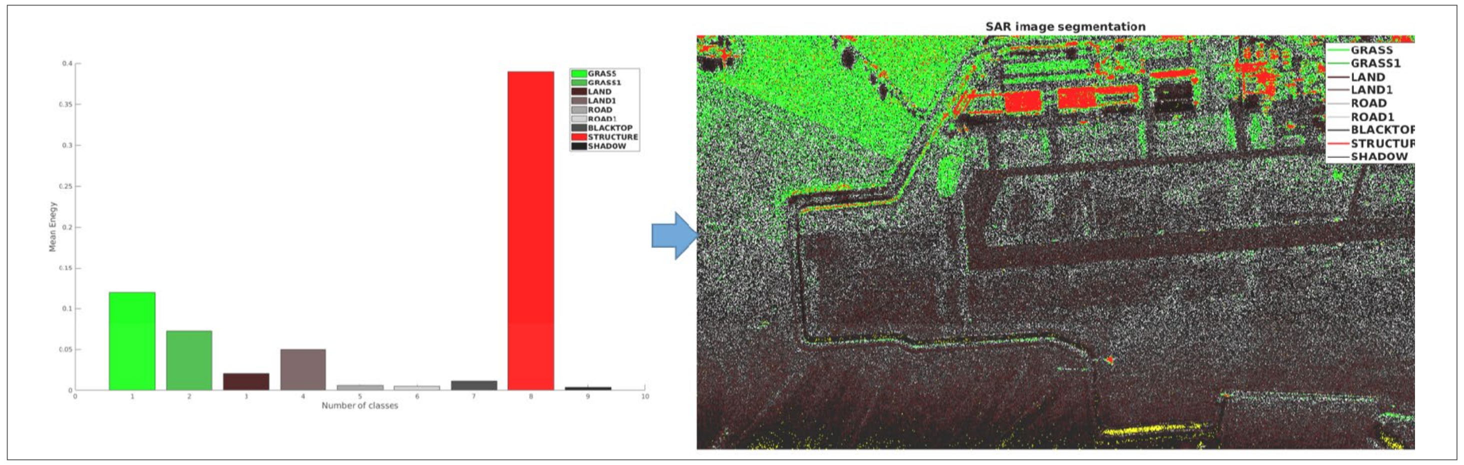
(a) Cogito conceptual idea and operative scenario



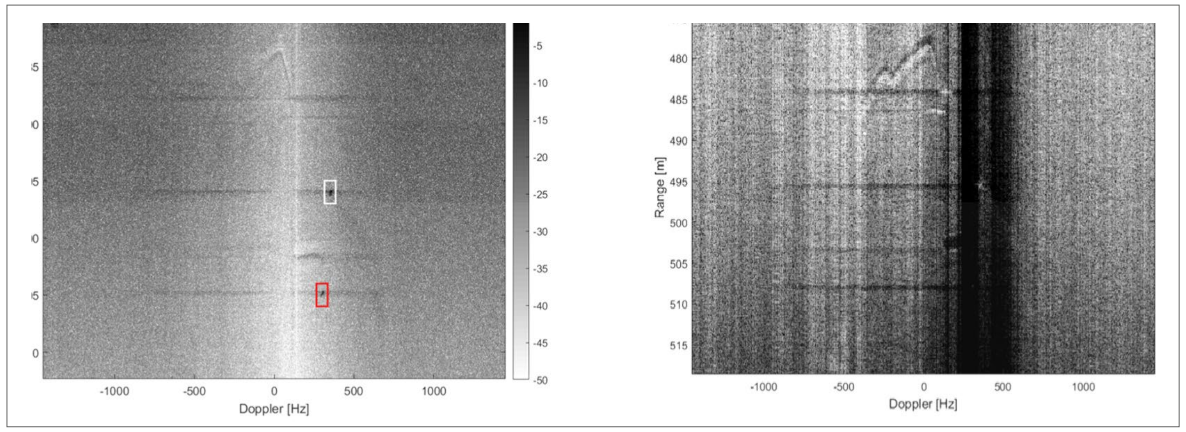
(b) Block diagram for a cognitive radar high level architecture [2]



(c) Cognitive SAR image segmentation-first step: Blue squares are the areas for which the SAR segmentation algorithm shows uncertainties [2]



(d) Cognitive SAR image segmentation-second step: The SAR segmentation memory is updated using the new detected pixels and the SAR segmentation is performed again only on the blues areas that are now classified pixel by pixel without uncertainties [2]



(e) Cognitive SDAP for moving target detection (left) compared to the non cognitive SDAP algorithm (right). The results on the right side shows a worsts mitigation of the background clutter and the moving targets (those highlighted with the rectangles in the left figure) cannot be detected.
This is a portion of the SAR image shown in (d) (below the landing strips of the airport) [2]

Simulation 1: fine tuning strategy against SNR

Performance comparison: ← SNR (Time ↓)

Accuracy [%]	28.52dB	24.42db	19.21dB	16.57dB	15.44dB	12.30dB
Baseline classifier	100	100	90.75	83.25	74.92	58.58
Fine tuning at 28.52dB	100	100	90.75	83.17	74.92	50.04
Fine tuning at 24.42dB	100	100	99.83	83.17	74.92	58.58
Fine tuning 9.21dB	100	100	100	83.25	74.92	52.63
Fine tuning at 16.57dB	100	100	100	83.17	74.92	66.31
Fine tuning at 15.44dB	100	100	100	83.17	83.17	66.47

Error rate [%]	28.52dB	24.42db	19.21dB	16.57dB	15.44dB	12.30dB
Baseline classifier	0	0	4.62	8.38	12.54	20.71
Fine tuning at 28.52dB	0	0	4.75	8.42	12.54	24.98
Fine tuning at 24.42dB	0	0	0.839	8.38	12.54	23.09
Fine tuning 9.21dB	0	0	0	8.38	12.54	23.63
Fine tuning at 16.57dB	0	0	0	8.42	8.42	16.85
Fine tuning at 15.44dB	0	0	0	8.42	8.42	16.76

Precision [%]	28.52dB	24.42db	19.21dB	16.57dB	15.44dB	12.30dB
Baseline classifier	100	100	92.87	89.97	87.48	84.18
Fine tuning at 28.52dB	100	100	92.72	89.94	81.64	-
Fine tuning at 24.42dB	100	100	99.83	89.94	81.64	83.97
Fine tuning 9.21dB	100	100	100	89.97	81.66	74.26
Fine tuning at 16.57dB	100	100	100	89.94	89.94	85.65
Fine tuning at 15.44dB	100	100	100	89.94	89.94	85.68

(f) An example of how the system adapts the training set against SNR variations over time. The performances are measured in terms of accuracy, error and precision. The cognitive classifier, after the on-line learning process (last line of each table), is compared with a non-cognitive classifier (baseline classifier, first line of each table)

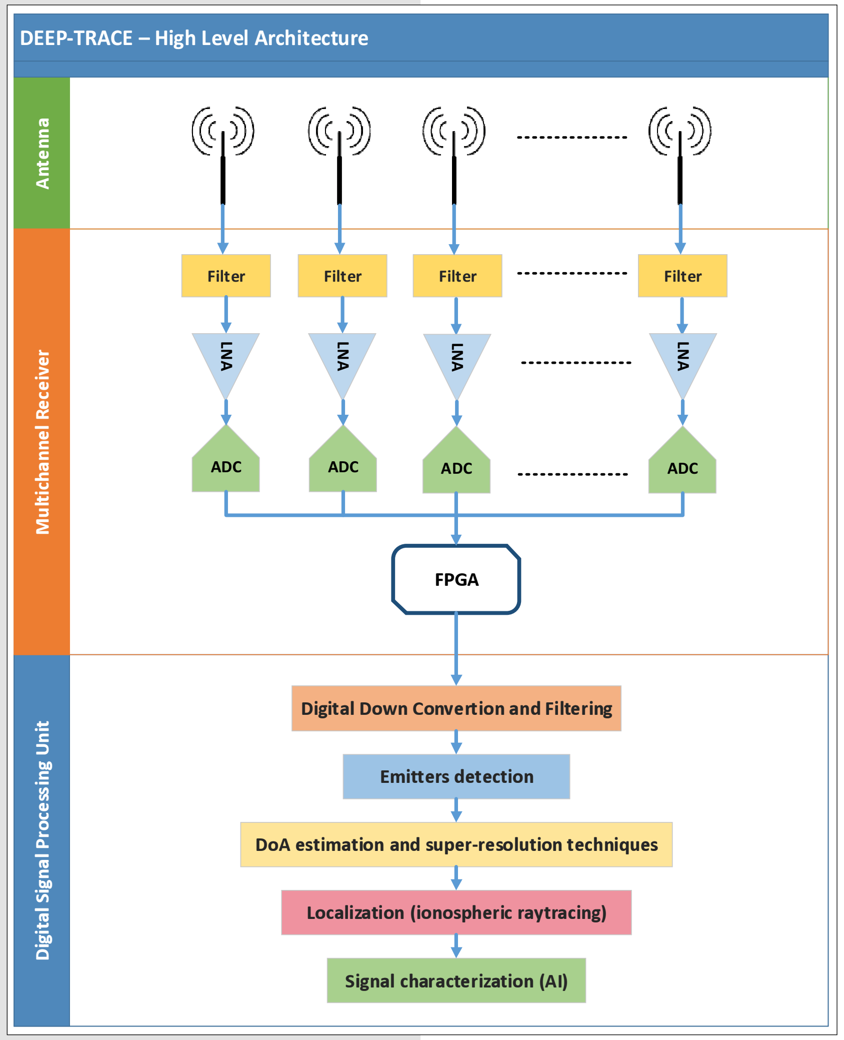
PROJECT DEEP-TRACE

Deployable performing HF radio goniometer compact system for C-ESM applications

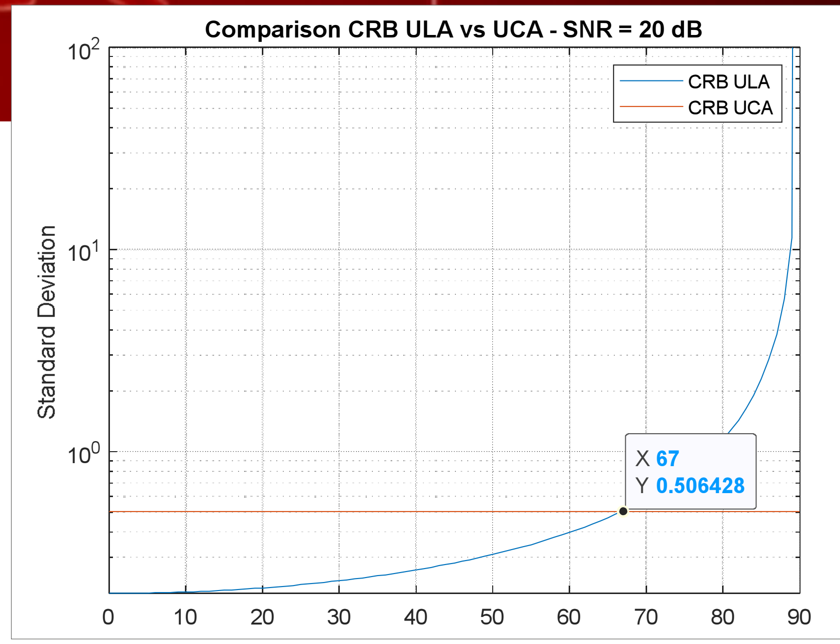
The DEEP-TRACE project aims at realizing a multi-channel system based on an array of compact receiving antennas for receiving, digitizing and analysing HF band signals for C-ESM applications. This configuration is conceived to cope with compactness, easy deployment, modularity and scalability requirements.
The proposed technological solution allows to estimate the direction of arrival (DoA) of the received signals, to characterize the signal through the use of Artificial Intelligence (IA) techniques and to localize the source making use of 3D ionospheric propagation models for the signals transmitted in sky-wave mode. This system could be used individually or in a multi-sensor / multi-platform configuration. This last configuration, appropriately dislocated, will allow the geolocation of the HF source, regardless of the type of propagation (sky-wave or surface-wave).
The main innovative aspects of this proposal are:

1) An accurate miniaturization of the antennas combined with the use of an active and flexible adaptation, able to use the radiating elements in array configuration to be deployed both in the terrestrial environment (urban or not) and naval;
2) Implementation of different DoA estimation techniques even in the presence of a limited number of sensors, and comparison of their performance in terms of mean square error of estimate and robustness to mismatches between design conditions and actual conditions determined by the ionospheric channel;
3) Positioning techniques of the individual receiving nodes in a sensor network configuration. The techniques adopted will optimize the spatial configuration of the nodes in order to minimize the Cramer-Rao limit on the DoA estimate;
4) Localization based on 3D ionospheric propagation models able to reconstruct the e.m. path from the receiver to the transmitter through the ionospheric channel;
5) Artificial Intelligence (IA) for classifying the detected signal (e.g.: type of propagation, continuous / pulsed wave, modulation, etc.).

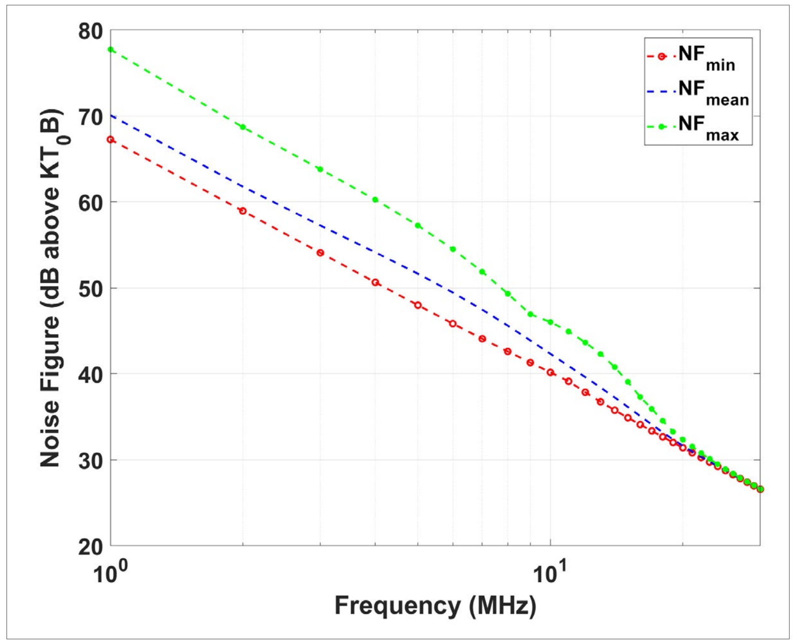
Technical Sheet
Funding institution:
Italian MoD
Project partners
ECHOES s.r.l., FreeSpace s.r.l
Project duration
June 2021 – June 2024
Involved countries
Italy



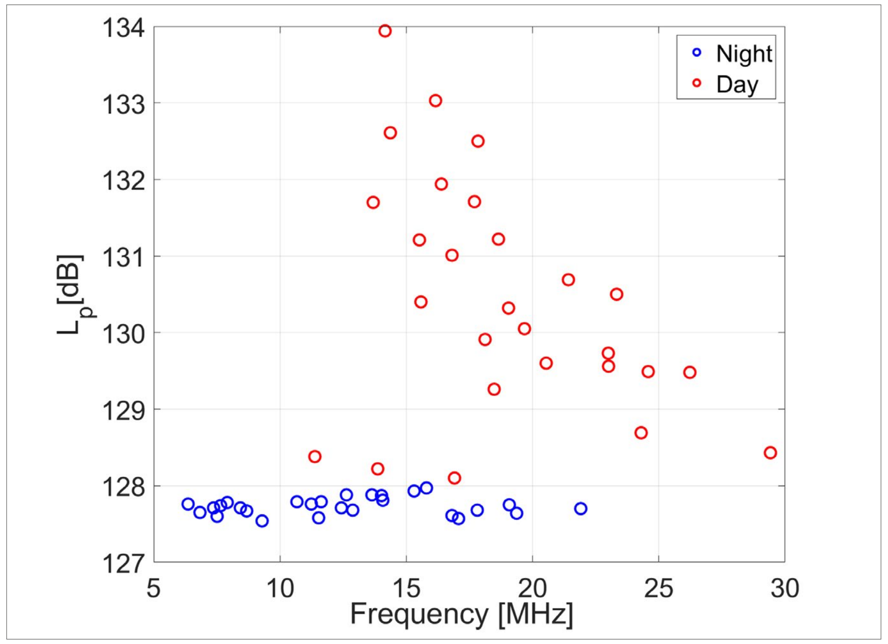
(a) DEEP-TRACE High-level architecture



(b) Beamforming performance comparison: Uniform Linear Array (ULA) vs Uniform Circular Array (UCA) (SNR=20 dB)



(c) External noise levels in HF bandwidth (rural environment)



(d) Propagation losses of a radio link TX-RX=2253 km versus frequency for 54 ionospheric conditions (season/time of day/Sun Spots Number)

PROJECT 3D-ISAR

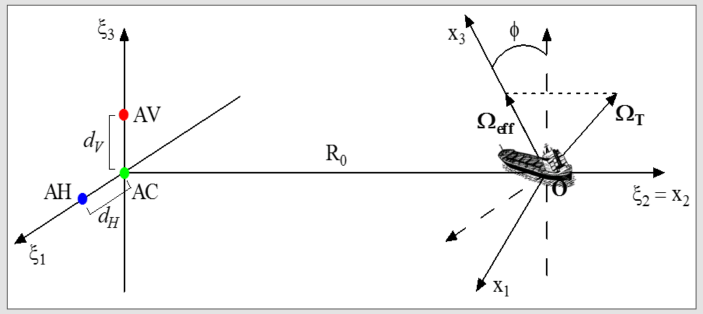
ATR by means of Polarimetric ISAR Images and multi-view 3D InISAR

Both homeland security and asset protection in military scenarios require high performing modern surveillance systems in terms of accuracy and response times. Examples are the protection of ports, airports, critical infrastructures, immigration monitoring and prevention, maritime and air surveillance from various types of platforms (land, sea, air and space). In this variety of applications there is the need to have a support for the recognition of the threat produced by an approaching target.
The aim of the project 3D-ISAR is twofold:

- Demonstrate that the use of polarimetry may enhance the performance of 3D Interferometric ISAR imaging systems. 3D InISAR has been proven effective to generate a 3D point target model of non-cooperative moving targets. To further enhance its performance, a fully polarimetry 3D InISAR algorithm is under development that will be able to combine the advantages of fully polarimetry radar over single polarisation radar and those of 3D InISAR over 2D ISAR imaging.

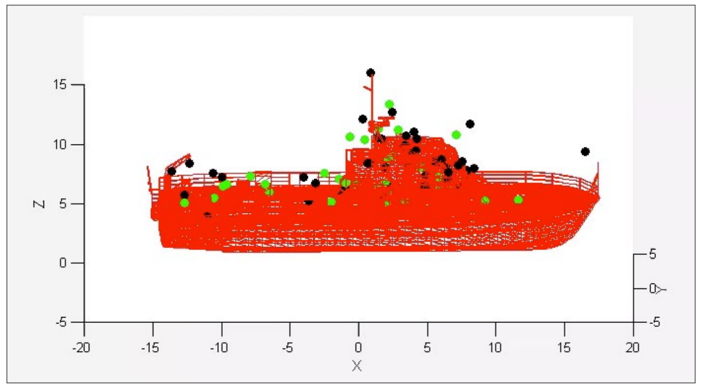
- Develop a non-cooperative target recognition algorithm that exploits fully polarimetric 3D InISAR results.
  The use of 3D target reconstruction instead of 2D ISAR images may overcome the problem of creating large and costly databases as 3D reconstructed images can be compared directly to geometrical target CAD models or simulated 3D e.m. CAD models. Moreover, the use of machine learning will be also investigated in this work for the implementation of NCTR algorithms.

Figure 1 shows the 3D-InISAR imaging configuration that allows for point-like 3D ISAR images to be formed. An example of the reconstruction of a 3D InISAR image is displayed in Figure 2. Figure 3 shows instead an example of a 2D fully polarimetric ISAR image of a tank. Scattering centres are extracted by applying a full-pol CLEAN technique and superimposed to the ISAR image. Finally, Figure 4 shows a high-level block diagram of the 3D InISAR imaging system followed by the application of a classifier.

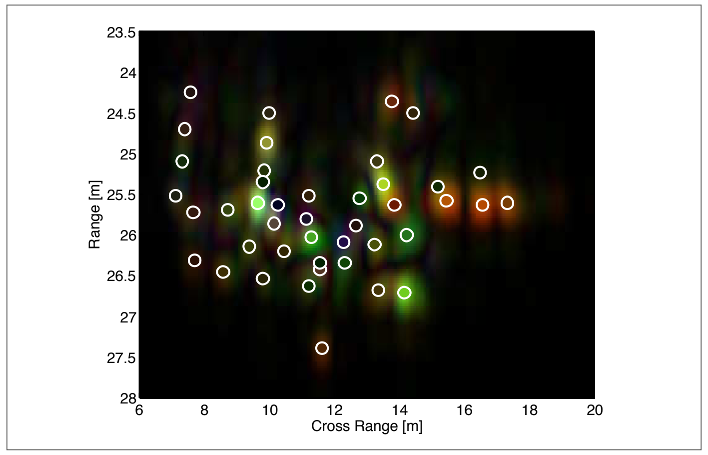


(a) 3D-InISAR imaging configuration © [2015] IEEE. Reprinted, with permission, from [F. Salvetti et al., "Multistatic 3D ISAR image reconstruction," 2015 IEEE Radar Conference (RadarCon), 2015];

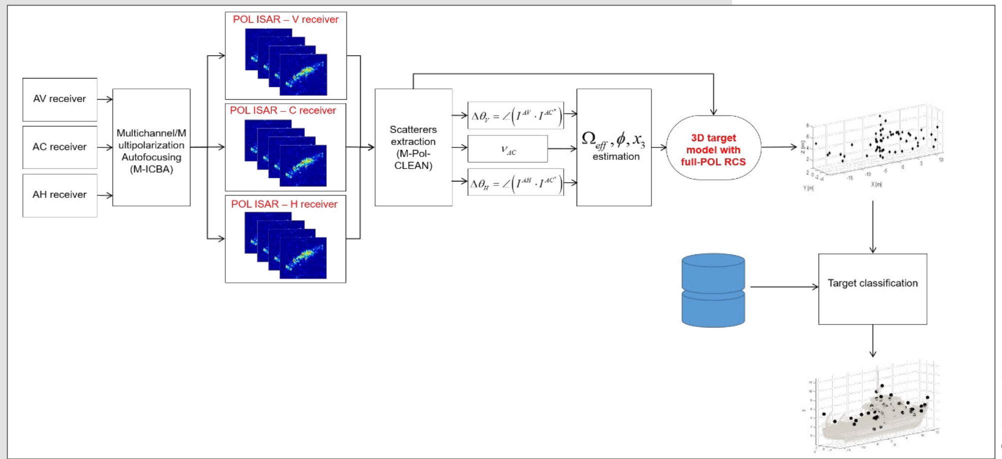
Technical Sheet
Funding institution:
ONR GLOBAL
Project partners
CNIT RaSS
Project duration
September 2020 - September 2023
Involved countries
Italy



(b) Example of 3D InISAR image reconstruction



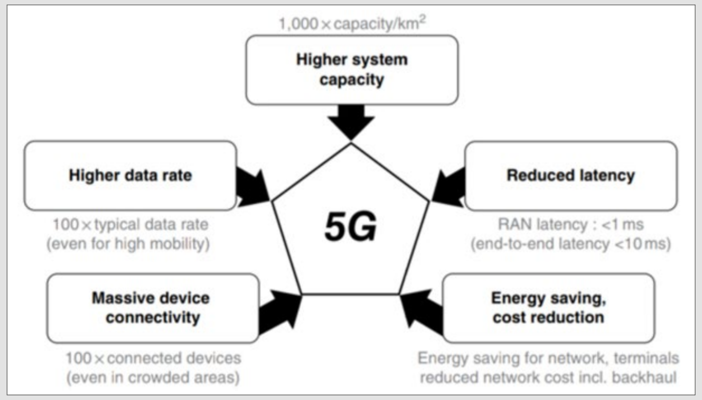
(c) 2D Fully polarimetric radar image of a tank with superimposed scattering centre estimation Copyright © 2008 M. Martorella et al. This is an open access article distributed under the [Creative Commons Attribution License](). [M. Martorella, A. Cacciamano, E. Giusti, F. Berizzi, B. Haywood, B. Bates, "CLEAN Technique for Polarimetric ISAR", International Journal of Navigation and Observation, vol. 2008, Article ID 325279, 12 pages, 2008. https://doi.org/10.1155/2008/325279]



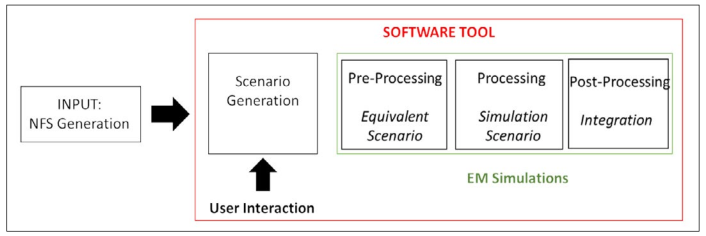
(d) An high level block diagram of the software algorithm that we be implemented.
The project activities will focus on the development of the multichannel/multipolarization CLEAN algorithm and on the development of a target classifier

The transition to 5G involves the installation of new antennas (phased array antennas) on new sites or on existing ones.
The coverage and connectivity requirements of the 5G network and the need to share the same site (co-siting) by multiple operators implies the installation of an increasing number of antennas on the same infrastructure (pole/tower).
The reduced available space and the mechanical constraints can determine an increase in electromagnetic coupling (i.e. the reduction of isolation) among antennas with the consequent degradation of the performance of the overall system.
The aforementioned problem, as a matter of fact, determines the maximum number of antennas that can be installed on the same support and their separation distances. Therefore, the isolation assessment is a crucial task that affects the 5G wireless network deployment. Nowadays, this problem can be addressed by means of electromagnetic full-wave simulations or by measurements campaigns; both these approaches have drawbacks: the first, needs huge hardware resources due to the use of mm Waves; the second, needs a very long time due to the large number of the antennas beams directions to be tested.
The purpose of this project is to develop a novel electromagnetic method able to compute the isolation between multiple 5G antennas in order to minimize the use of full-wave simulations and measurement campaigns. The method will be implemented in a dedicated software tool to be used by RF engineers and antenna designers to analyze and to assess various antennas configurations before their installation in real environment.

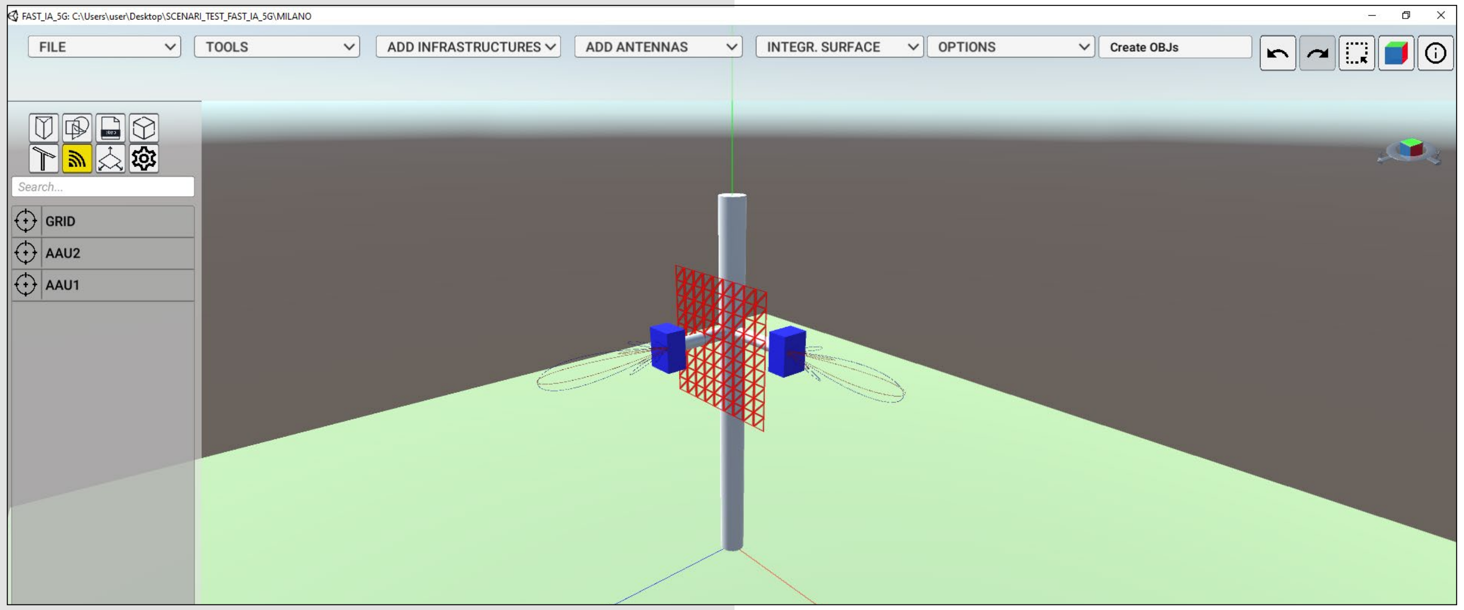
Technical Sheet
Funding institution:
Huawei Technologies Italia Srl
Project partners
University of Pisa, Netfarm srl
Project duration
June 2020 - June 2021
Involved countries
Italy



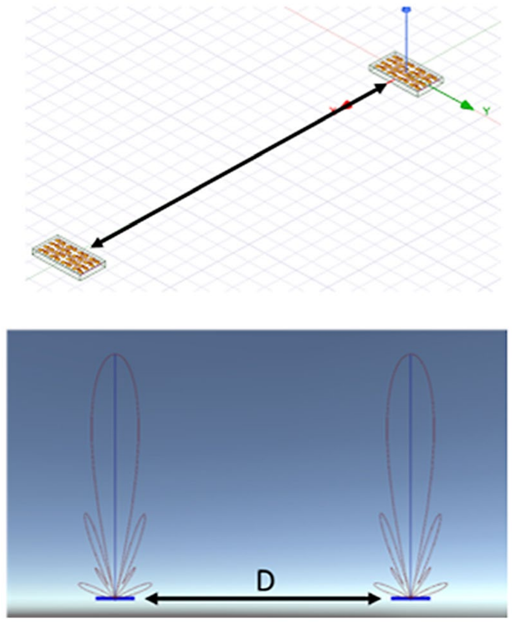
(a) Example of isolation between two horn antennas (26GHz) measured in the anechoic chamber and computed by means of the Tool Most relevant targets of the 5G mobile network;



(b) Application of the proposed computational method

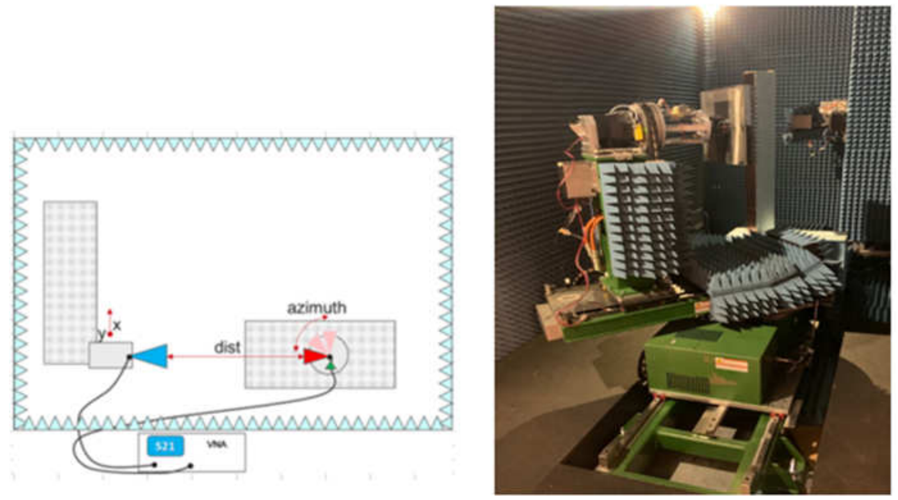


(c) Example of a scenario created by means of the Graphical User Interface of the software tool: two 5G antennas placed on the same pole



Scenario 1: Side by Side (E-Plane Matching) – D = 1m	FE-BI	Our Tool
Isolation	63.59 dB	62.21 dB
RAM	128 GB	64 GB
Simulation Time	18 h	50 sec.
Scenario 1: Side by Side (H-Plane Matching) – D = 1m	**FE-BI**	**Our Tool**
Isolation [dB]	56.91	56.62
RAM	128 GB	64 GB
Simulation Time	18 h	50 sec.

(d) Example of isolation between two array (X band) in side by side configuration computed by means of fullwave simulation and the Tool



Polarization Antenna Tx	Polarization Antenna Rx	Azimuth SGH2650 [deg]	Isolation (Measured) [dB]	Isolation (HFSS) [dB]	Isolation (Our Tool) [dB]	Error (Measure vs Our Tool) [dB]
H	H	0	-15.0	-15.1	-15.0	0.0
V	V	0	-14.7	--	-15.1	0.4

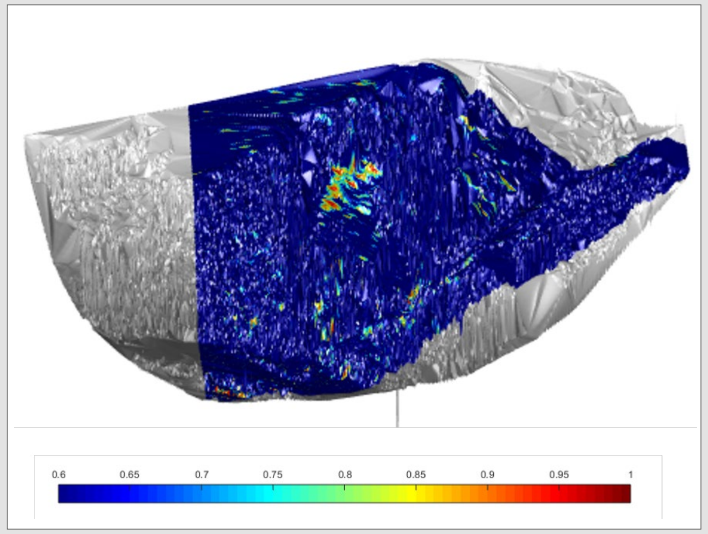
(e) Example of isolation between two horn antennas (26GHz) measured in the anechoic chamber and computed by means of the Tool

PROJECT GLIDE

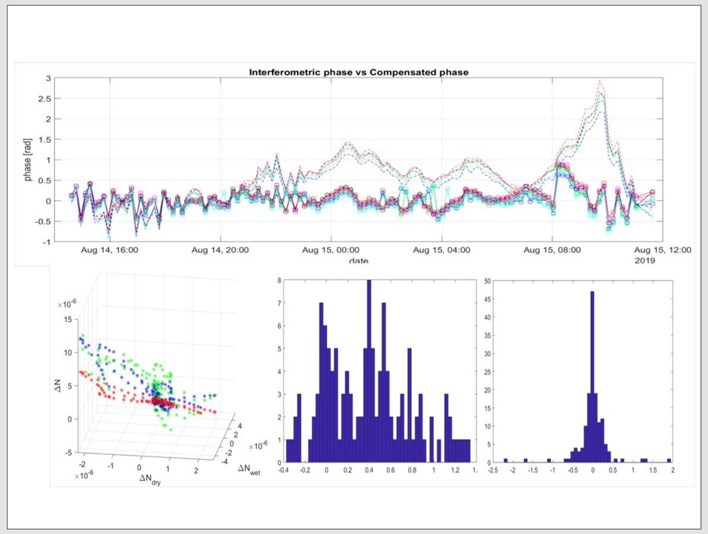
HiGhLy SensItive Radar Change Detection

The goal of this project is to significantly improve radar change detection by accurately studying the phenomenology associated with radar interferometry and by developing improved algorithms that are based on such an understanding. The main objectives to be achieved within this project are:

- Study the phenomenology associated with repeat pass interferometry, such as atmospheric interference, temperature and humidity variations, etc.
- Develop effective change detection and structure deformation estimation algorithms. These algorithms are based on the results of the phenomenological study in order to outperform state-of-the-art algorithms.
- Real data acquisition with a ground-based Synthetic Aperture Radar (SAR) system to support the phenomenological study and to validate the developed algorithm.
- Real data acquisition with an airborne SAR system to validate the change detection and interferometric algorithms.
- Study distributed spaceborne SAR systems as well as SAR systems based on formations of Unmanned Aerial Systems (UAS) and optimise them based on the mission goals and on the phenomenological scenarios.



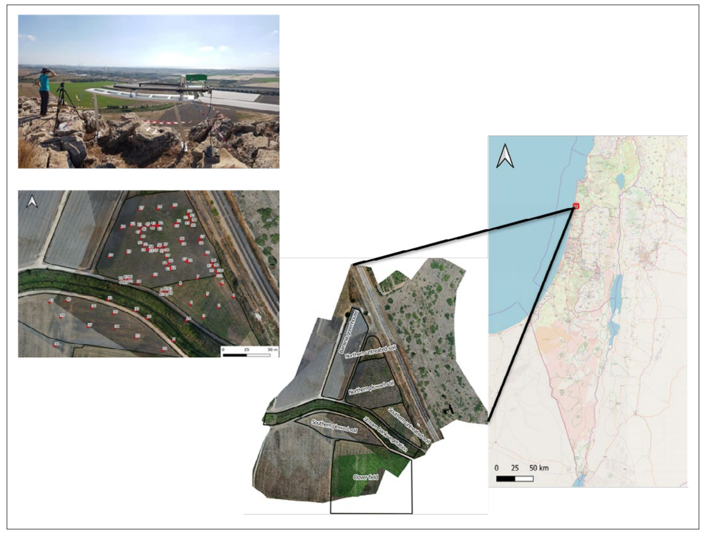
(a) Coherence map after fine Co-Registration (ECHOES s.r.l.)



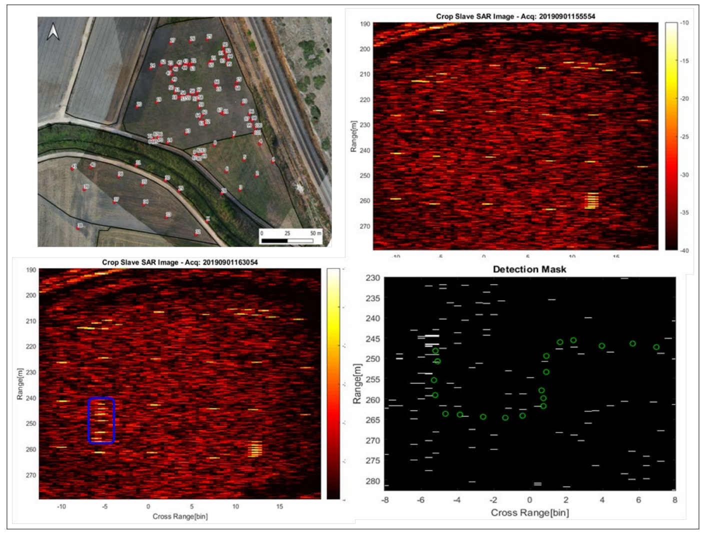
(c) Atmospheric compensation results obtained on the Israeli dataset

The project has already seen the ground-based measurement campaign completed as well as a first phenomenological study completed. Results have shown that the newly developed mathematical models are able to significantly improve the estimation of the interferometric phase, which in turn improves the system ability to detect changes and measure millimetric deformations. Airborne radar measurements will be carried out in 2021/Q1 as well as a final algorithm validation.

Technical Sheet
Funding institution:
Ministry of Defence
Project partners
University of Naples, ELTA Systems, ECHOES s.r.l
Project duration
February 2019 - July 2021
Involved countries
Italy, Israel

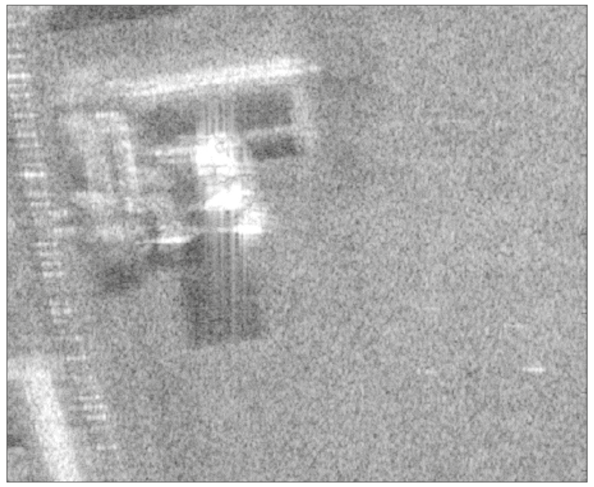


(b) Ramat HaNadiv site where part of the experimental measurements were conducted

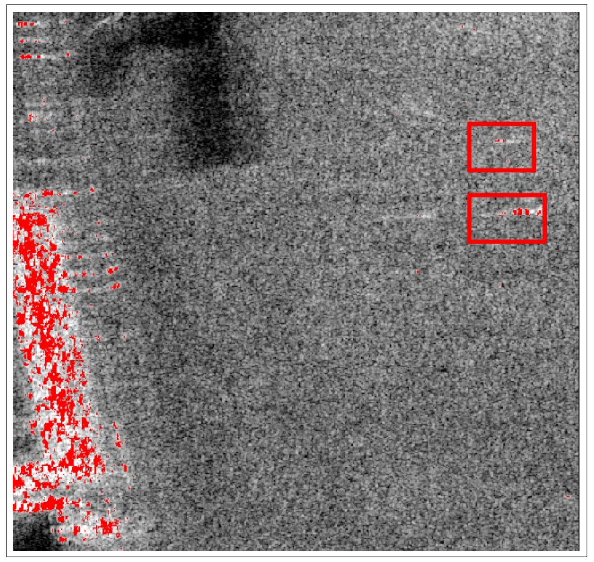


(d) Preliminary Incoherent Change Detection (ICD) results on Israeli dataset

(e) SAR image of the illuminated area formed with BackProjection algorithm



(f) Crop of the area of interest where two corner reflectors were placed



(g) Results of ICD superimposed with the original SAR image where two corner reflectors were detected

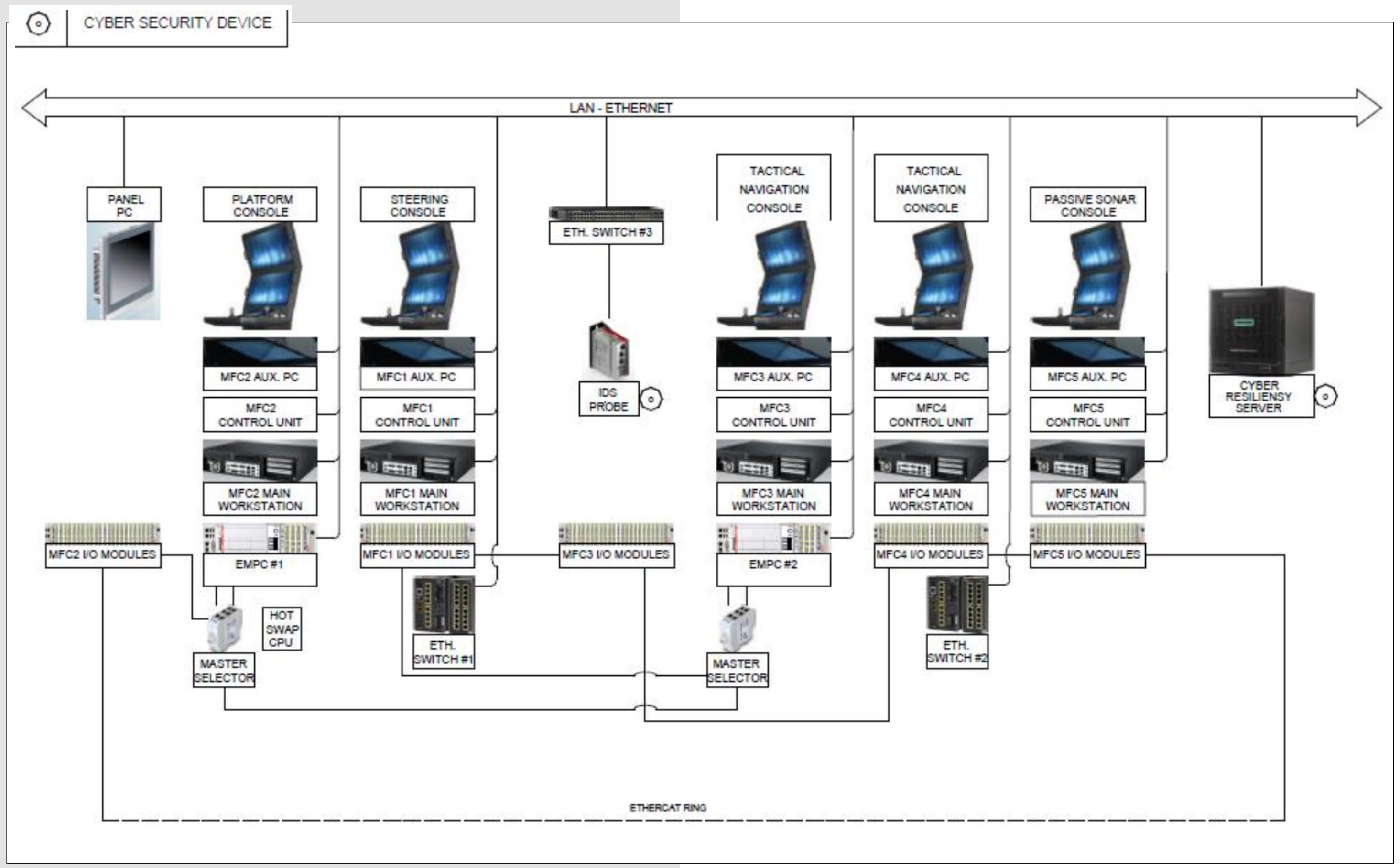
PROJECT ISS DRASS

Integrated Submarine System with DRASS

The aim of this project is to analyse the technological and algorithmic solutions for a Target Motion Analysis (TMA) system for submarines.
Particularly, a software-defined architecture is proposed to host a wide spectrum of software applications dedicated to the management of on-board systems. Using a distributed shared server architecture, data can be available from multiple users at the same time, without the need of execution on dedicated consoles. The proposed architectural approach allows to limit the space required for the HW, for which an architecture has been proposed, introducing energy saving factors and minimizing the need for heat dissipation. The modularity of the architecture makes it easy to integrate possible updates both HW (to increase system computational capabilities) and SW (to update automatic information analysis capabilities) and ensure interoperability with solutions from any future developments.
Given the software-defined nature of the system, a particular focus has been the cybersecurity aspects, adopting a security-by-design strategy, which provides the integration of special security systems in each element of the developed system. In addition, advanced artificial intelligence algorithms were taken into account to allow the identification and mitigation of any cyber attacks.

Finally, TMA and data fusion algorithms has been analysed, focusing on the integration of different type of sensors in the system without the need to modify the software.

Technical Sheet
Funding institution:
DRASS
Project partners
.....
Project duration
January 2021 - October 2021
Involved countries
Italy



(b) Possible hardware configuration of a command and control system

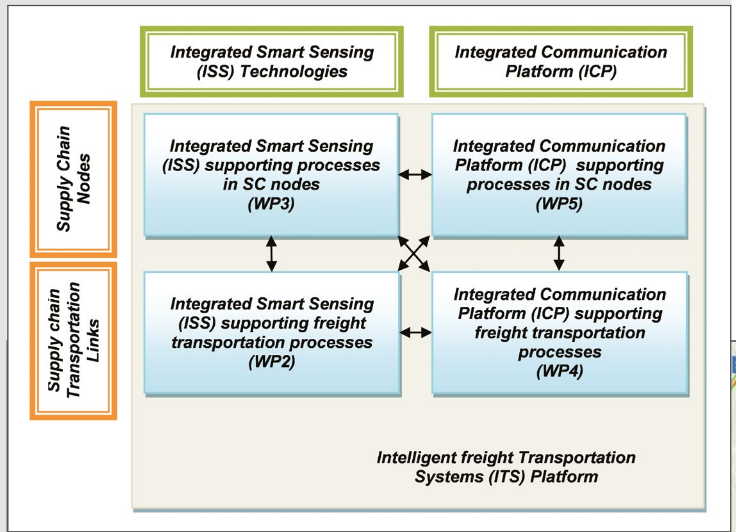
PROJECT ITS-ITALY 2020

Intelligent Transportation System – ITALY 2020

investiamo nel vostro futuro

The ITS-2020 project aims to research, design and develop innovative ICT based solutions to support logistics and transportation processes, with special attention to the inter-modal freight transportation, in order to improve their effectiveness and efficiency. In this context, it is very important to apply technologies based on sensors (Integrated Smart Sensing) and systems supporting the information exchange among the supply chain players (Integrated Communication Platform) for enhancing the logistics process in its base components, namely 'nodes' (e.g. ports and inter-ports) of the supply chain and transportation 'arches'. To this aim, the project has been structured into seven work packages (WPs) whose main research areas are:

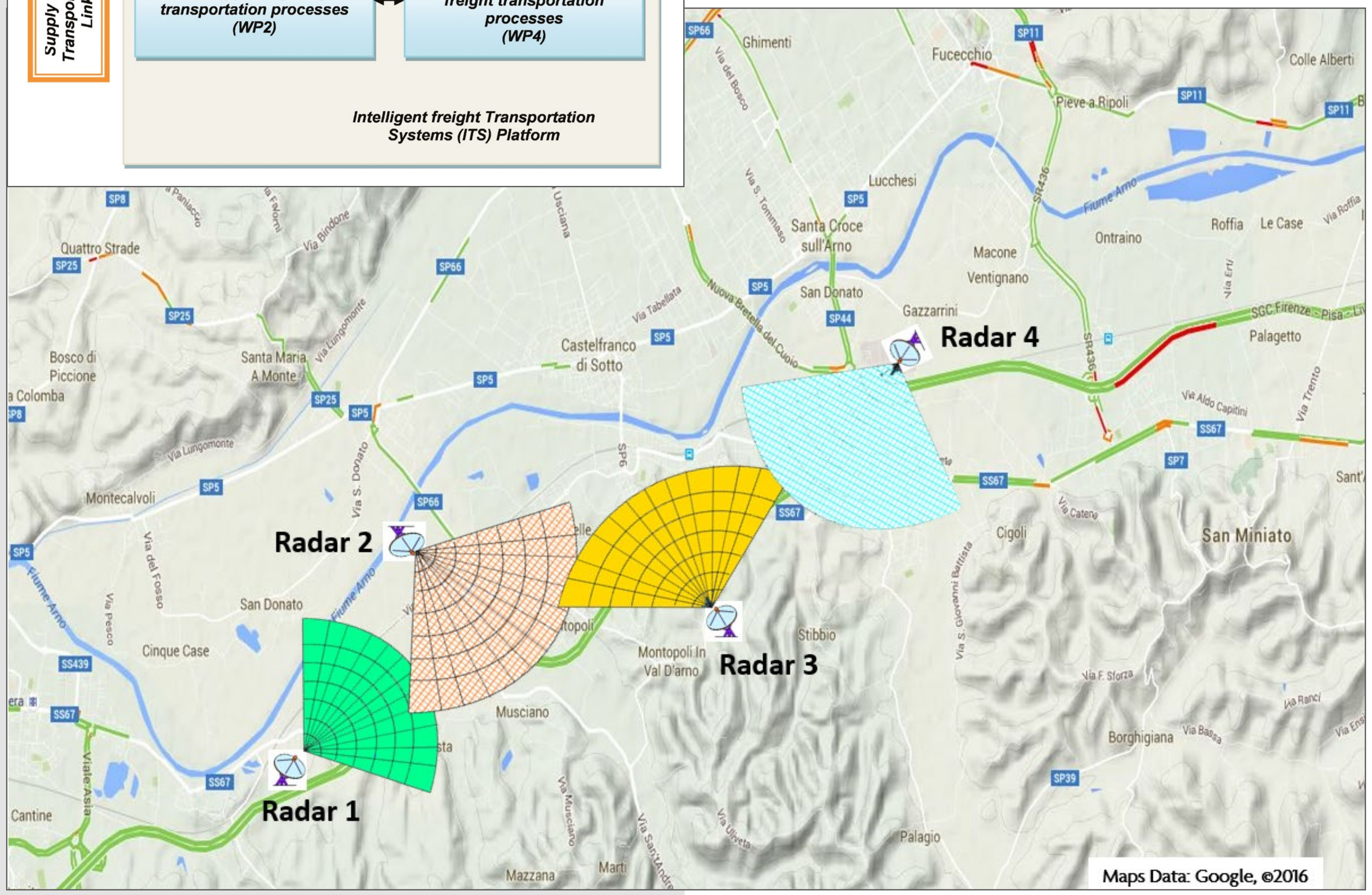
- Development of integrated smart sensing solutions to support both transport and node processes
- Development of data communication system solutions to support both transport and node processes



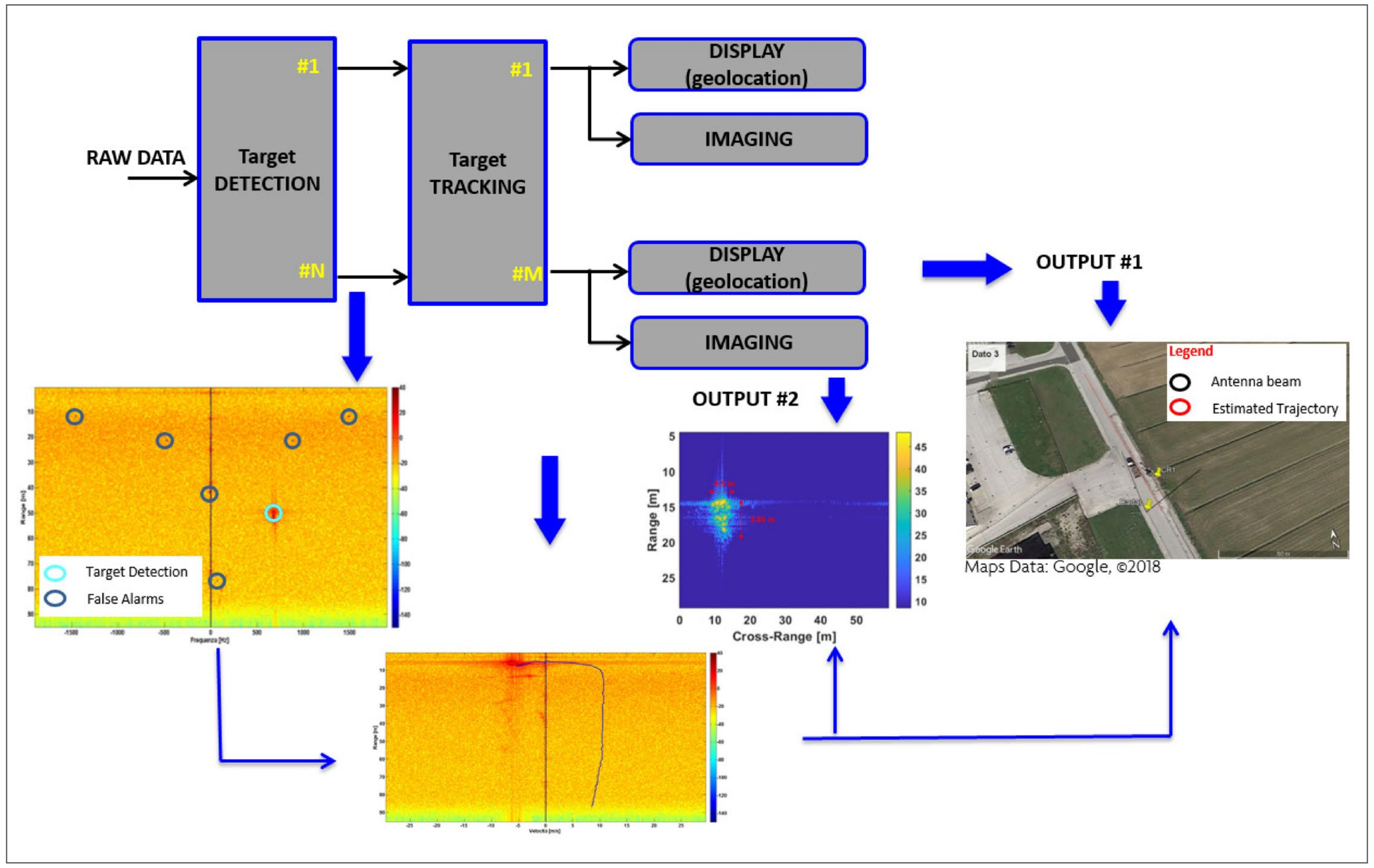
The main result of the project will be the development of effective tools able to integrate traditional services, i.e. transportation and warehousing, with information-based services, such as information transfer, route planning, monitoring (i.e. tracking and localization). In the framework of ITS-ITALY project, CNIT-RaSS proposes a radar systems network for vehicle monitoring and classification based on radar images. The processing architecture and the proposed algorithms have been validated through real data acquired during the experimental phase.
Project web-site: http://51.89.224.112/itsitaly2020/

Technical Sheet
Funding institution:
MIUR
Project partners
POLIMI, POLITO, Softeco Sismart, TESI, Mobysys, Gruppo SIGLA S.r.l., Almaviva, RDW, Rotas Italia S.r.l., IVECO S.p.A., IDNOVA S.r.l., IB S.r.l., Aitek, TELECOM, Exprivia, Gianetti Ruote, IDS, STAR, VITROCISET, OPTISOFT, ART S.p.A., HUPAC
Project duration
February 2014 -February 2021
Involved countries
ITALY

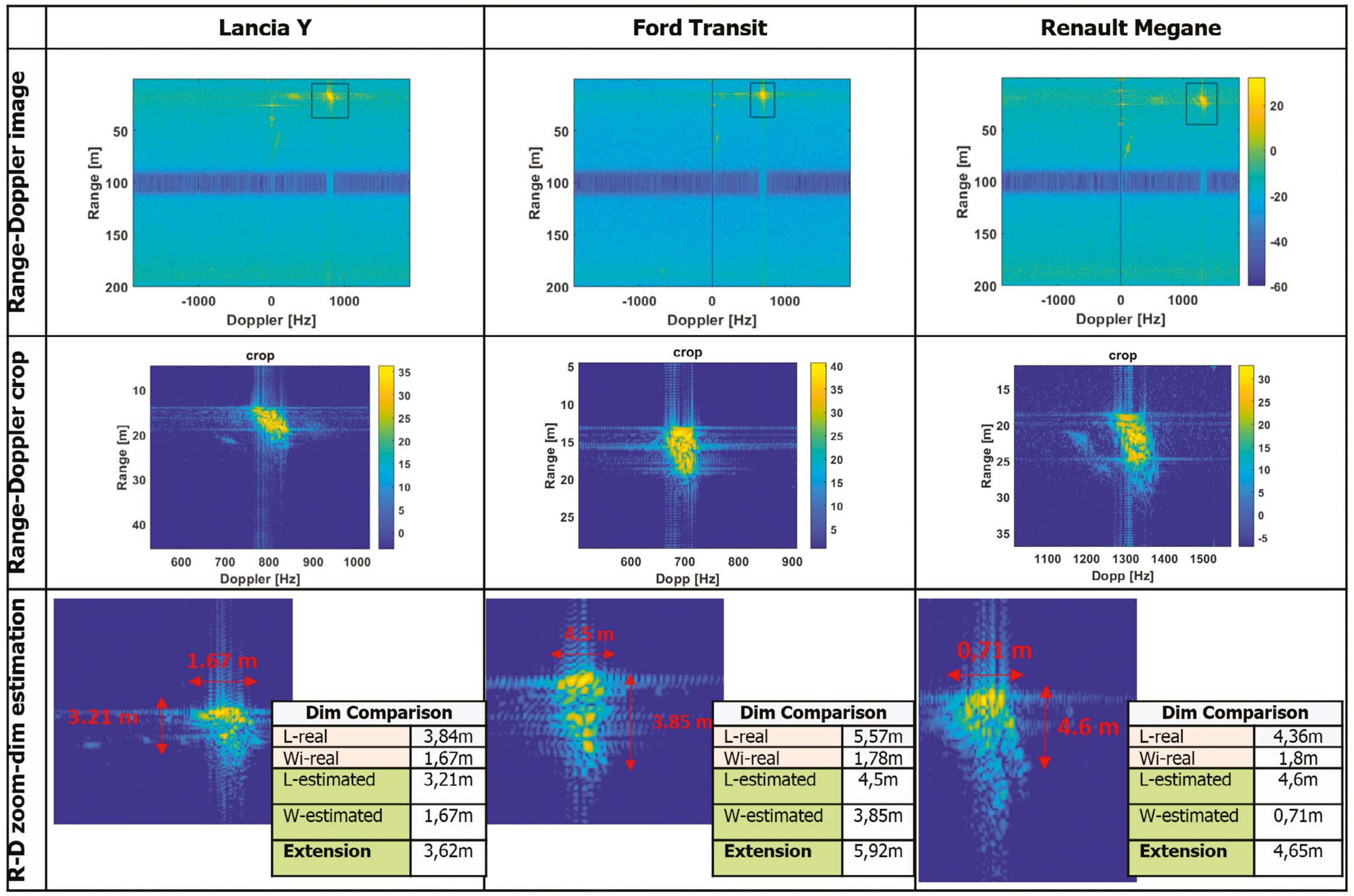
(a) - ITS concept architecture



(b) - Network of sensors for the surveillance of wide areas and the localization of freight transports



(c) - Processing Block Diagram and relative output



(d) - Results of vehicle classification based on radar images

PROJECT MIRACLE II

Micro-Satellite Clusters II

In background surveillance there is a need for near-global coverage at medium temporal and spatial resolution. In targeted operations, there are similar needs for localized coverage at a very high temporal and spatial resolution. The objective of this project is to cover both needs through:

- Virtual SAR constellations
- Cluster of real SAR satellites

in combination with new SAR technology both on the instrument and processing side. The application scenarios for the project will be maritime security and defence applications in the Mediterranean and High-North areas. In surveillance and security, our assets should maximise the following operational performance characteristics:

- Spatial coverage
- Temporal coverage
- Spatial resolution
- Low vulnerability
- Timeliness

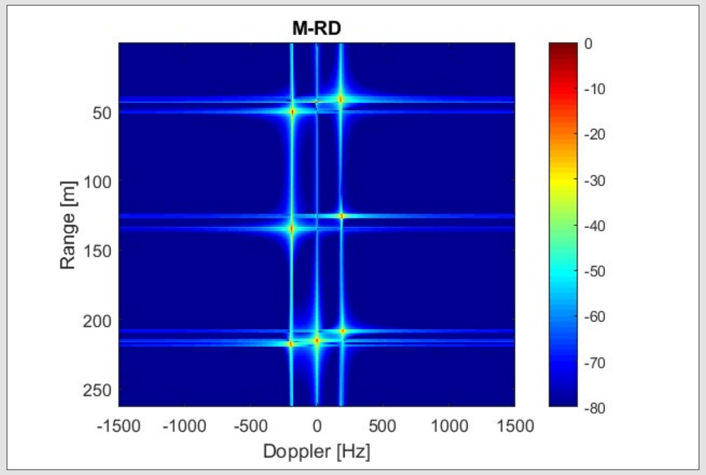
Current assets, including the way they are used, are not able to meet user needs and requirements in an optimal manner. During this project, we will analyse new and forthcoming technologies to provide increased performance of future assets and optimal use of existing assets at an affordable cost. The following key elements will be analysed:

- SAR Cluster of small, relatively inexpensive satellites
- New SAR technologies
- Virtual SAR cluster utilizing existing and future SAR missions
- Maritime modes, including optimal ship detection and imaging

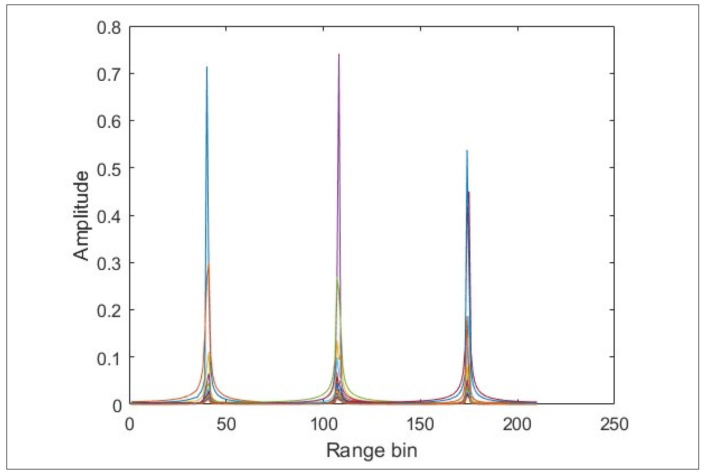
In this project we:

- Propose an architecture for such constellations
- Demonstrate technical solutions and key technologies
- Demonstrate the value for military users.

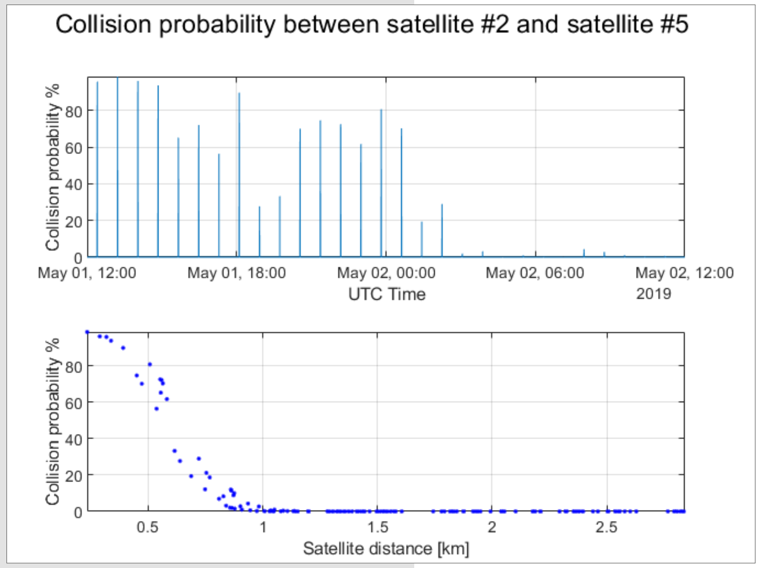
Technical Sheet
Funding institution:
European Defence Agency (EDA)
Project partners
Kongsberg, FFI (Norwegian Research and Defence Establishment), Università La Sapienza
Project duration
January 2018 - March 2021
Involved countries
Italy, Norway



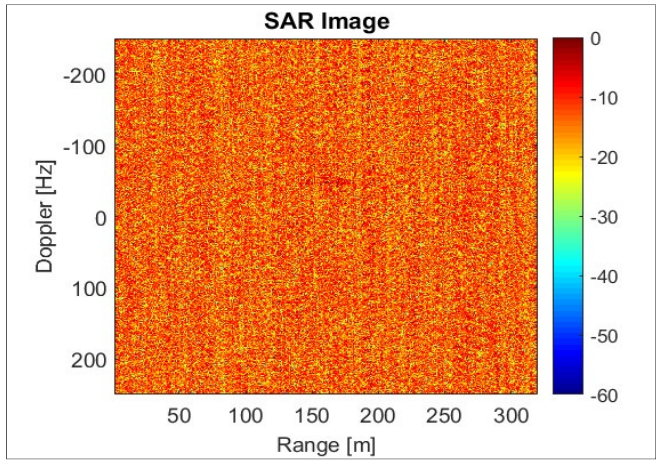
(a) Multichannel image formation with baseline length equal to 1.5 cm: range Doppler map;



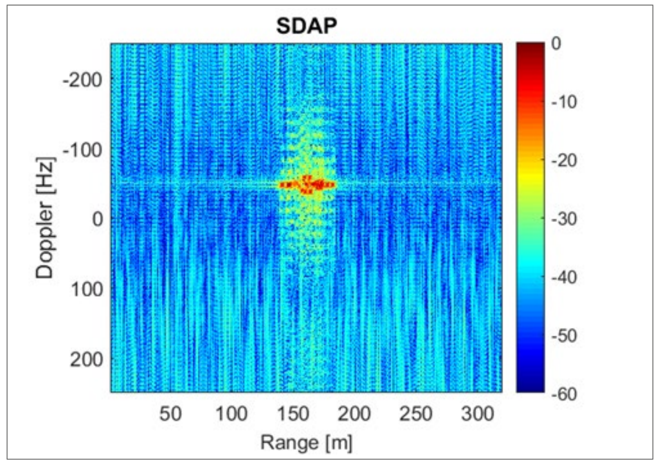
(b) Multichannel image formation with baseline length equal to 1.5 cm: slice along range dimension for a set of Doppler frequencies;



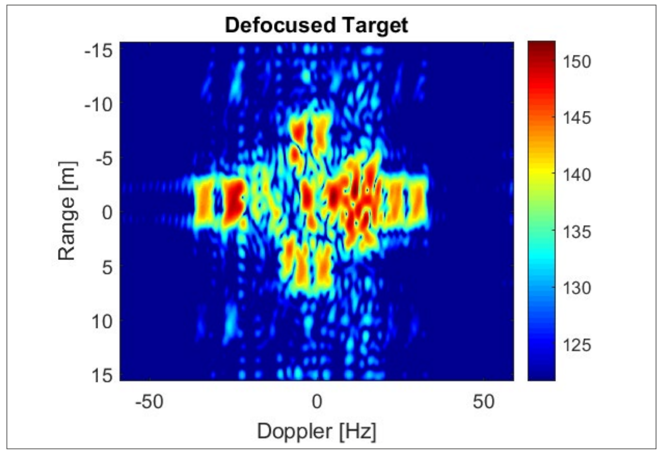
(c) Collision probability percentage value between two satellites in configuration for critical orbits in case of ground-based positioning, having standard deviation;



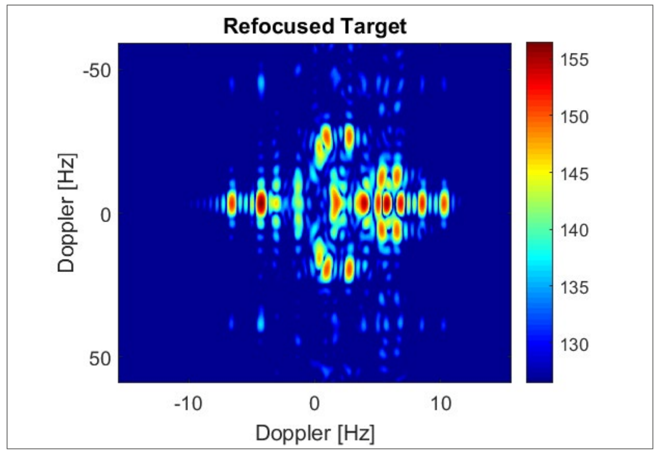
(d) Multichannel RD SAR image: before STAP processing in which the clutter is not suppressed;



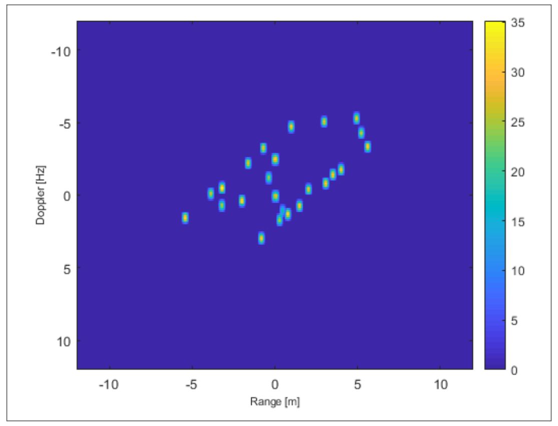
(e) Multichannel RD SAR image: after STAP processing;



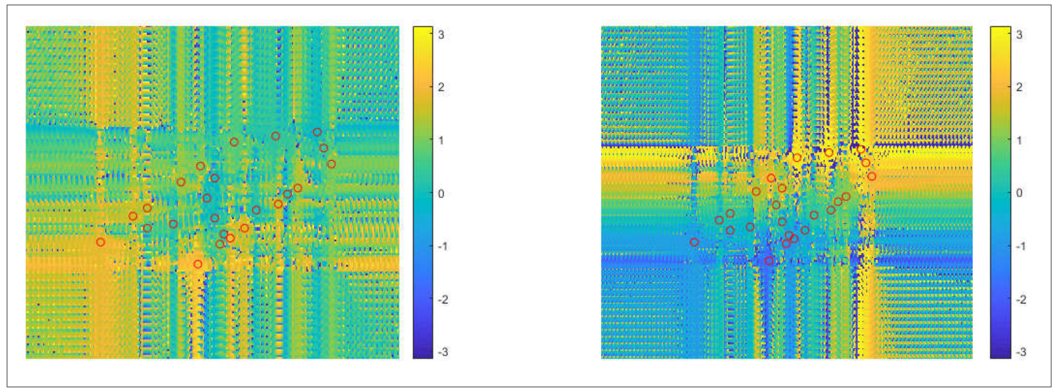
(f) SAR image before ISAR processing in which only the SAR motion is compensated and a mismatch between SAR and moving target is present;



(g) SAR image in which the target motion is compensated by applying ISAR processing;



(h) Results of the multichannel CLEAN algorithm. The algorithm extract the brightest scatterers from the ISAR images;



(i) Images show the two interferograms. The one on the left between deputy 2 and deputy 3, the other one between deputy 2 and deputy 1. The red dots are the scatterers coordinates. As it can be observed the phase variation over the target varies roughly in the phase period, namely in the range [-π±π]. This fact confirms that this target size is the maximum one that avoids

PROJECT NORMA

NOise imaging Radar network for covert air and MAritime borders Security

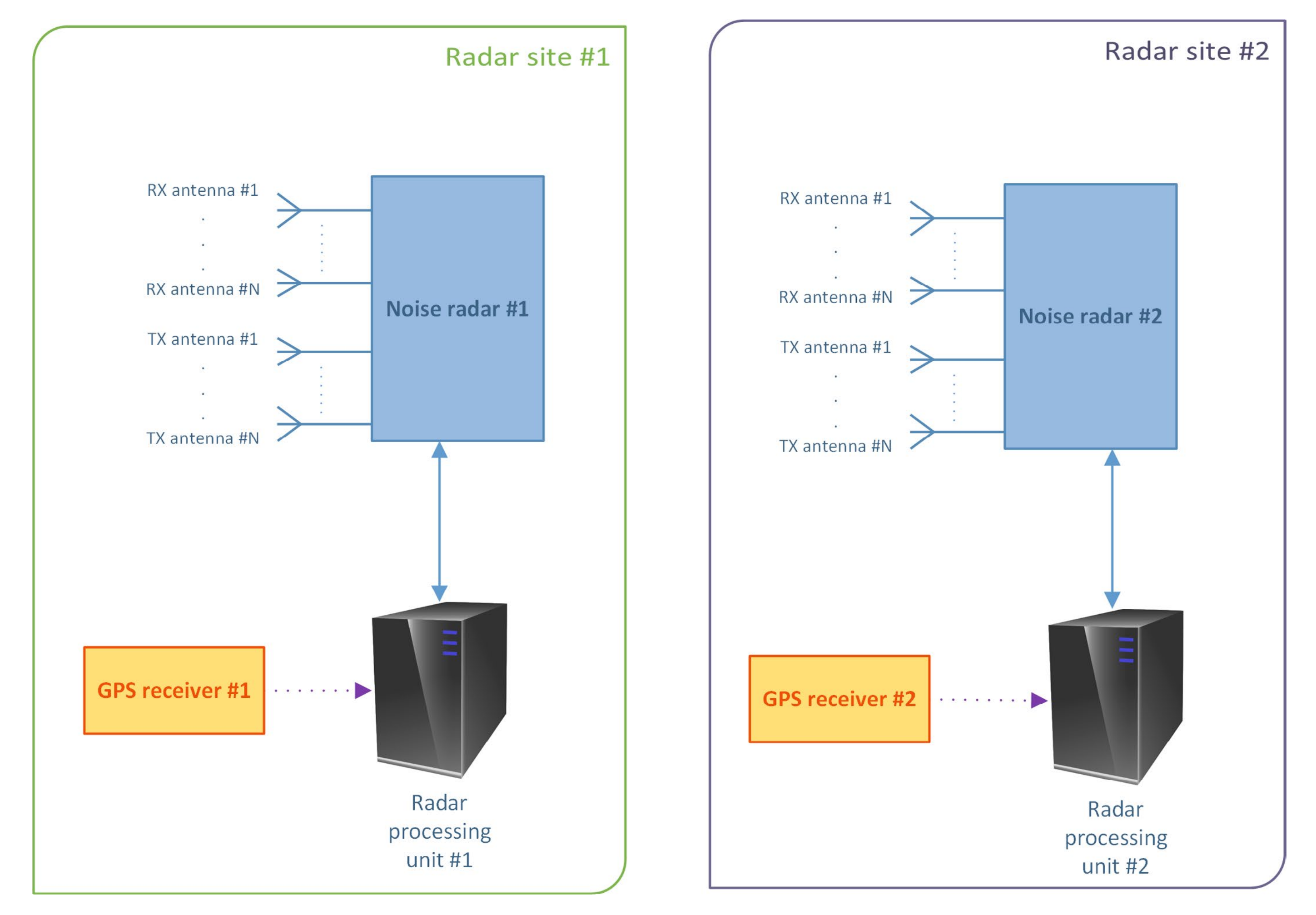
The project proposes the study, design, analysis and demonstrator realization of a wideband noise imaging radar network for air and sea border surveillance. The single radar sensor will be designed to work in three different modes: target RCS measurement, high range resolution profiling (HRRP or 1D imaging) and 2D-SAR and ISAR imaging. The main novelties of the NORMA system are:

- Use of random/noise and noise-like waveform which enables Low Probability of Intercept (LPI) characteristic and, hence, covert surveillance operational mode,
- Radar imaging capability with noise waveform, more specifically, high resolution range profiles and 2D- images of targets to be used for recognition and classification
- Ability to transmit stepped frequency continuous waveforms, which enable the detection of slow aerial (especially drones) and sea target in strong clutter environment
- Advanced signal processing, which provides the ability to detect targets floating in sea clutter environment
- Radar network, which enables bistatic, multistatic and Multiple Input Multiple Output (MIMO) RCS and 1D- 2D imaging for better target characterization and identification

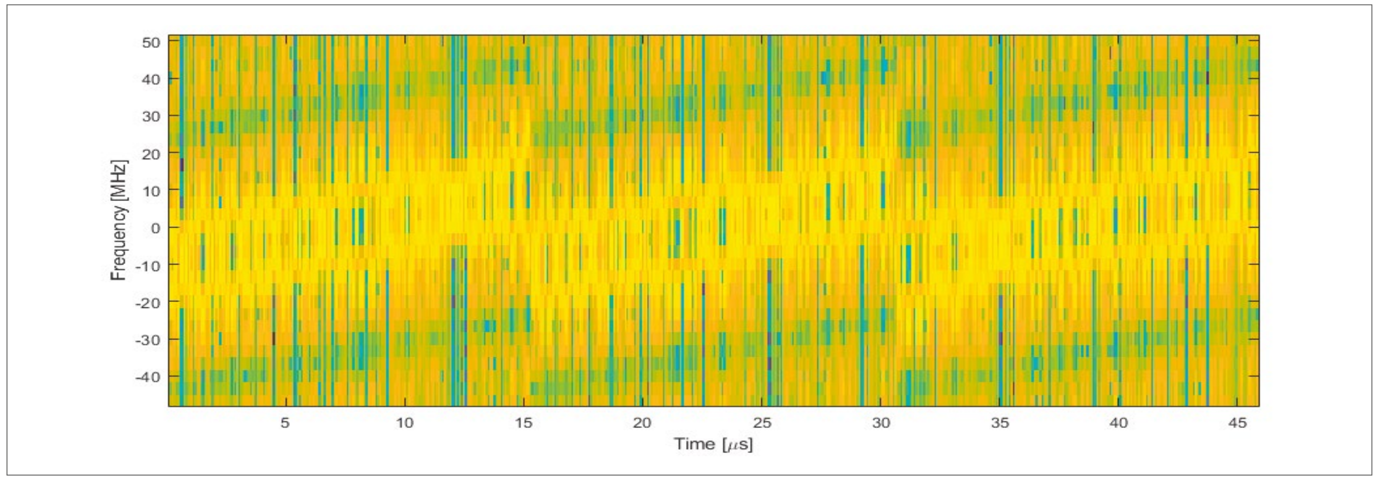
A technological demonstrator composed of a network of two noise imaging radar systems will be designed and developed.

The demonstrator will be designed to produce monostatic and bistatic, RCS measurements, high range profiling and 2D ISAR imaging. Test and validation will be performed in two scenarios: 1) The surveillance of the Russian-Ukraine air border around the area of Kharkov, as a practical real problem; 2) The surveillance of the sea area around the Livorno harbour (Italy) for monitoring illegal and threatening activities. Special attention will be paid to the detection of floating small size objects in sea clutter.

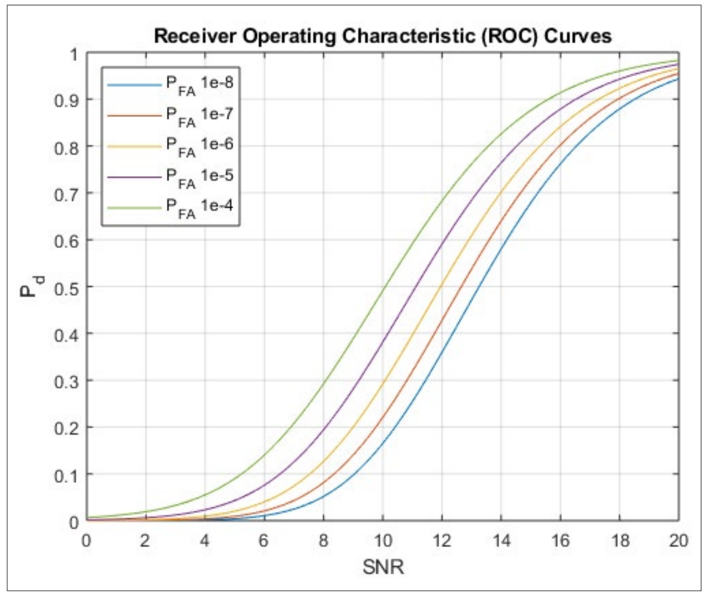
Technical Sheet
Funding institution:
NATO Emerging Security Challenges Division, SPS Programme
Project partners
IRE NASU with the participation of Echoes s.r.l
Project duration
May 2018 - May 2021
Involved countries
Italy, Ucraine



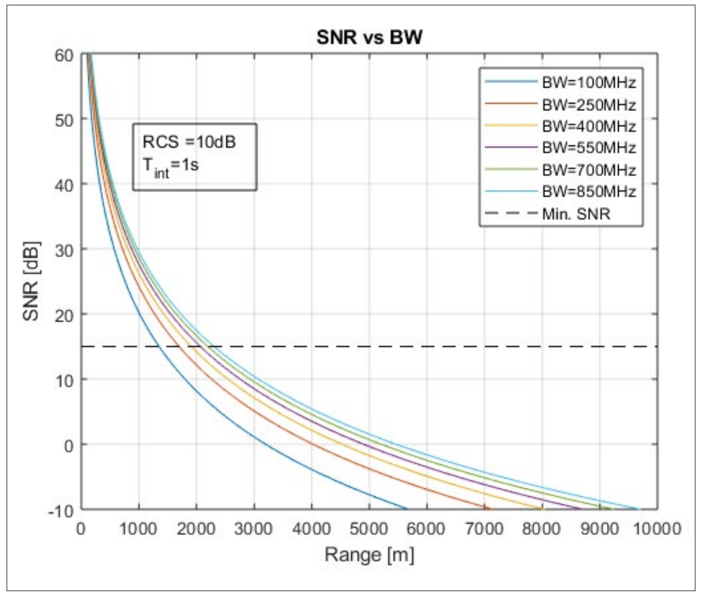
(a) - NORMA high level system architecture including two noise radars



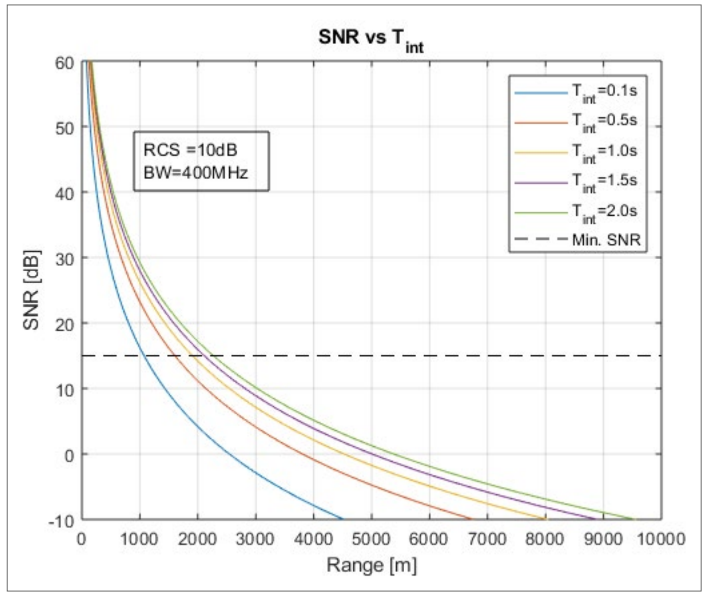
(b) PRBS (pseudorandom binary sequences) modulated FMCW waveform, 30MHz noise bandwidth. The typical "ramp" of FMCW signal is completely masked by the noise, leading to pseudo random noise like waveforms and, hence, LPI operations © [2020] IEEE. Reprinted, with permission, from [S. Tomei et al., «NORMA - A noise radar network for covert border surveillance,» 2020 21st International Radar Symposium (IRS), 2020]



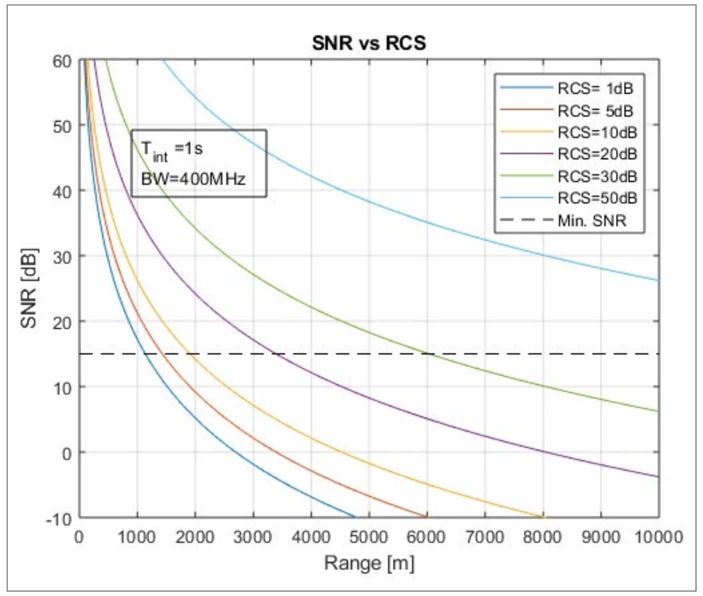
(c) ROC curves for Swerling III model



(d) SNR with respect to range distance with the varying of the target RCS



(e) SNR with respect to range distance with the varying of the coherent processing interval



(f) SNR with respect to range distance with the varying of the transmitted waveform bandwidth

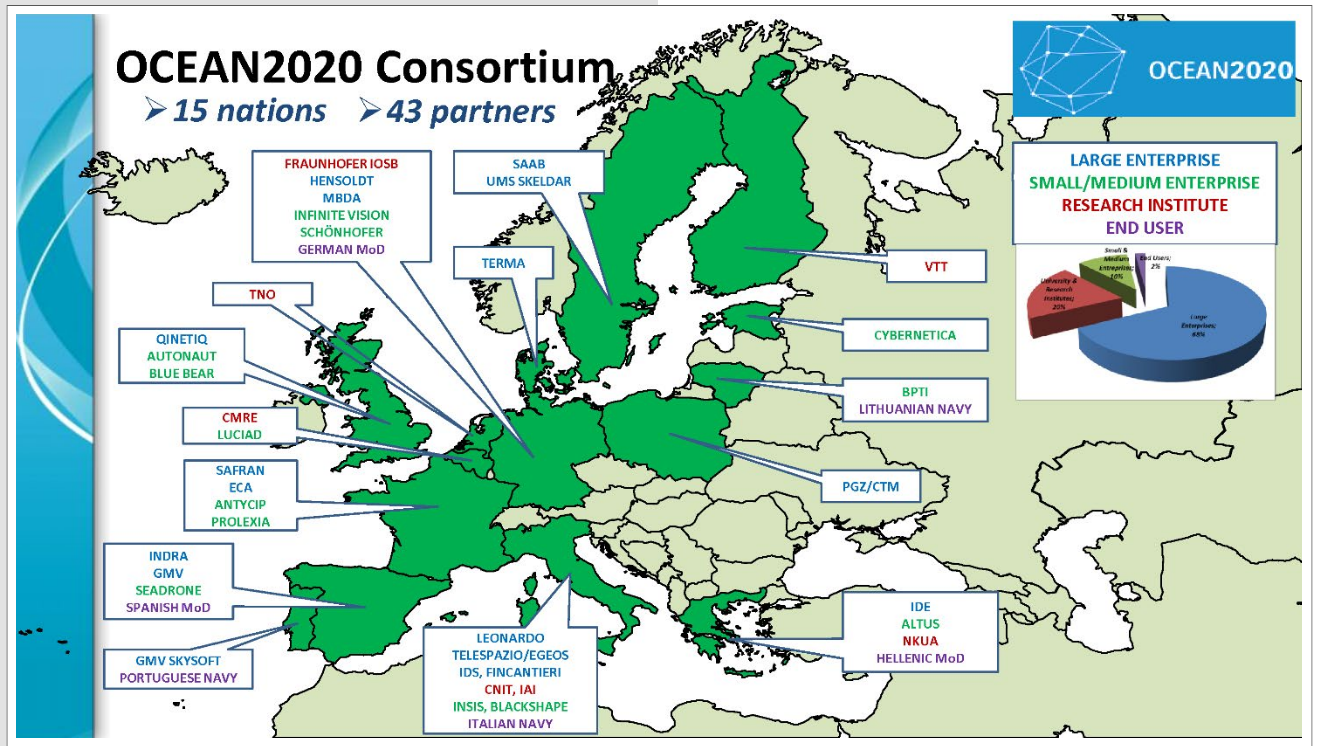
PROJECT OCEAN 2020

Open Cooperation for European mAritime awareNess

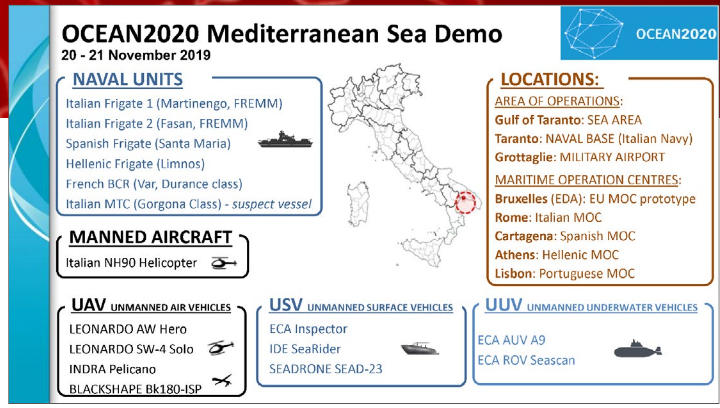
OCEAN2020 project has been conceived in the framework of the Preparatory Action on Defence Research (PADR), in the Research Action call on Unmanned Systems, focusing on the topic of Technological demonstrator for enhanced situational awareness in a naval environment.
The OCEAN2020 project will allow the enhancement and the integration of various types of unmanned platforms (fixed wing, rotary wing, surface and underwater) with the command and control centre of the naval units, providing for the data exchange via satellite with command and control centres on the ground. The joint and cooperative use of both pilot and unmanned platforms will also be demonstrated during the project. These innovative capabilities will be used for surveillance missions and maritime interdiction.
OCEAN2020 put together the specialists of technologies relevant to the sea domain for observing, orienting, deciding and acting naval operational tasks in maritime scenarios (from major Research Institutes, through Large and SME industries till the NATO Center of Excellence for Maritime Research and Experimentation) and fourteen countries representative of European northern and southern seas along with their relevant defense and security needs.
In very few words, all above represents the inclusive strength that OCEAN2020 intends to leverage to pave the way towards the future EU Defence Research Window and Capability Window, by integrating legacy with new technologies concerning unmanned systems, ISTAR payloads, lethal and non-lethal effectors and by exploiting data from multiple sources, including satellite assets, into a Standardized Maritime Picture, to secure a naval/maritime dominance.

Project web-site: https://ocean2020.eu/

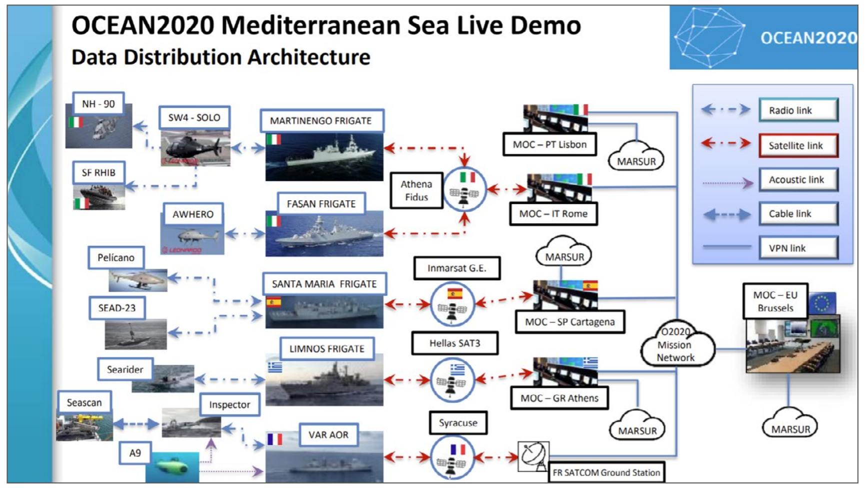
Technical Sheet
Funding institution:
EU
Project partners
Leonardo S.p.A, Sistemi Dinamici, Swidnik Spolka Akcyjna, NATO Centre for Maritime Research and Experimentation, Indra, Fraunhofer IOSB, Saab Kitebolag, Saab Kockums, Saab Dynamic, Dockstа Shipyard, Osrodek Badawczo- Rozwojowj Centrum Techniki Morskiej S.A., Safran Electronics & Defense, Intracom, Defense Electronics, TNO Defence Research, QinetiQ Ltd., Baltijos Pazangiu Technologiju Institutas, GMV IS Skysoft, MBDA Deutschland GmbH, MBDA Italy, IDS Ingegneria dei Sistemi, GMV Aerospace and Defence, Terma A/S, ECA Robotics, Fincantieri S.p.A., CETENA, e-GEOS S.p.A., Telespazio, VTT Technical Research Centre, Cybernetica AS, UMS Skeldar Sweden AB, Seadrone, AutoNaut Ltd, Blue Bear Systems Research Ltd, National and Kapodistrian University of Athens, Prolexia, Schönhofer Sales and Engineering GmbH, Antycip Simulation SaS, Infinite Vision GmbH & Co. KG., Insis SpA, Altus LSA, Luciad NV, Istituto Affari Internazionali, Hensoldt Sensors GmbH, Blackshape S.p.A., Marina Militare Italiana, Lithuanian Navy, Hellenic Ministry of Defence, Portuguese Navy, Spanish Ministry of Defence
Project duration
January 2018 - March 2021
Involved countries
Italy, NATO, Spain, Germany, Sweden, Poland, France, Greece, Netherlands, UK, Lithuania, Portugal, Denmark, Finland, Estonia, Belgium



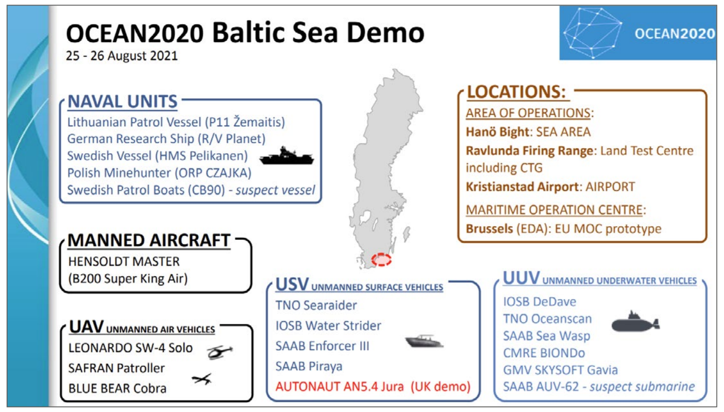
(a) OCEAN2020 project consortium



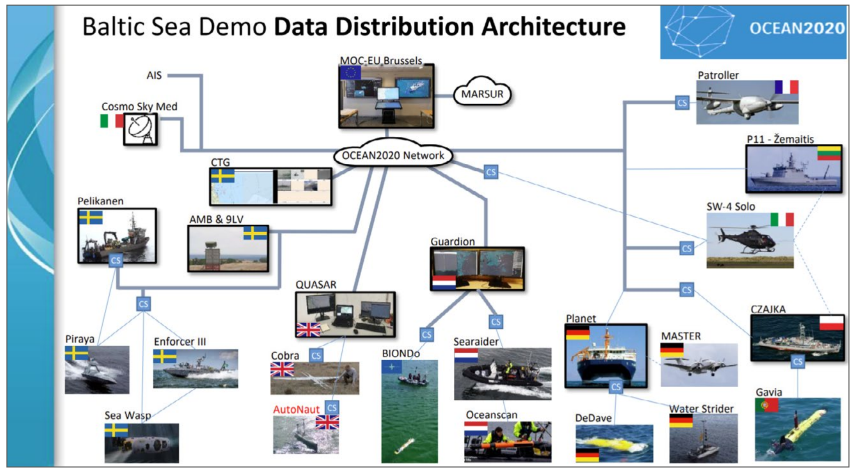
(b) OCEAN2020 Mediterranean sea demo details;



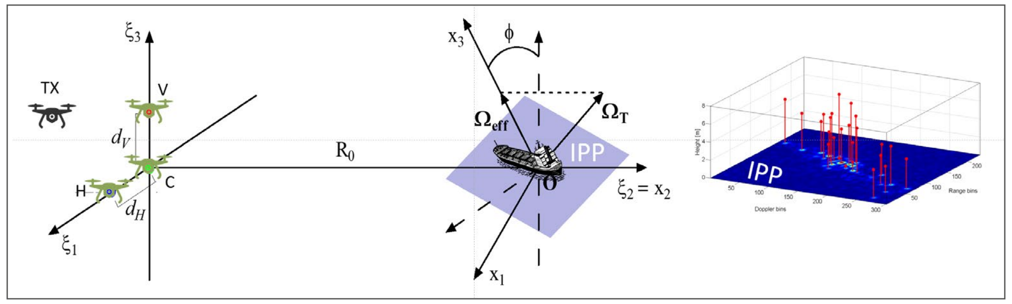
(c) OCEAN2020 Mediterranean sea demo: data distribution architecture;



(d) OCEAN2020 Baltic sea demo details;



(e) OCEAN2020 Baltic sea demo: data distribution architecture;



(f) 3D InISAR: Drone based 3D InISAR

PROJECT POSEIDON

A compact combined UaV Polarimetric Ku band radar and EO/IR sensor system for oil spill and sea debris detection

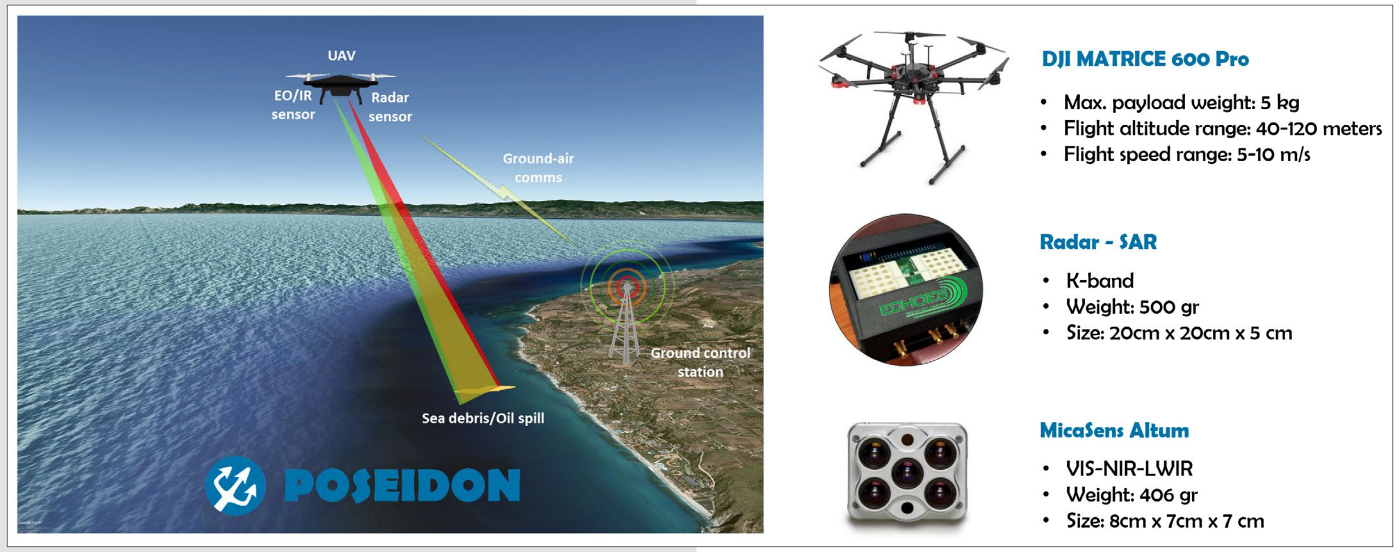
POSEIDON aims to protect sea life by designing an efficient response for the alarming rise of maritime pollution and its consequences. This is realized by making use of a compact multi-sensor system carried on UaVs equipped with radar sensors jointly operating with EO/IR cameras, which are able to effectively detect sea debris and oil spills.
Sea pollution is an issue that has attracted the attention of researchers worldwide in the last decades. The amount of pollution has been increasing in the last few years, posing a serious threat for marine life as well as affecting boats and the coastal ecosystem. Deliberate or accidental, disposal of man-made waste, such as fishing nets and plastic bags among others, as well as oil spills from large vessels, are two of the main sources of marine pollution.
POSEIDON aims to contribute with the provision of an efficient, innovative and expertly designed response to the alarming rise of marine pollution and its consequences.
The main novelties of the proposed system are:

1. Design of a compact, light and fully polarimetric radar with SAR imaging capabilities. The radar system is a 24/7, all weather surveillance sensor with enhanced capability of detecting floating debris and oil spills thanks to polarimetry and high spatial resolution.
2. Use of EO/IR sensors for a better identification of the type of debris and the extension of the oil spill to help the coordination of a prompt response for the mitigation of the problem.
To this end, recent advances in deep neural networks for object detection, segmentation, and classification will be explored. Application and development of ad-hoc fusion techniques for the two sensors to jointly operate in the same platform.

Project web-site: http://poseidon.cnit.it/

POSEIDON

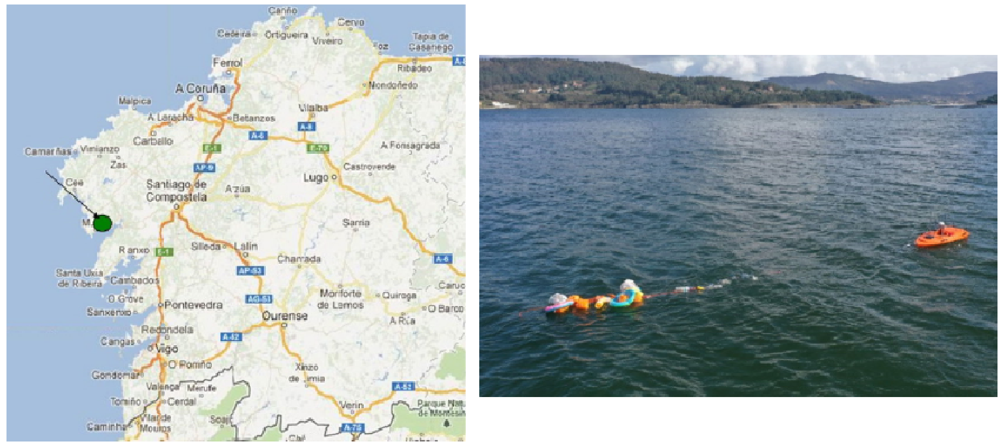
Technical Sheet
Funding institution:
MarTERA ERA-NET COFUND (EU) MIUR (IT) *Ministerio de Economia Y Empresa (SP)*
Project partners
CARTOGALICIA
Project duration
May 2018 - October 2021
Involved countries
Italy, Spain



(a) - POSEIDON system and its main components

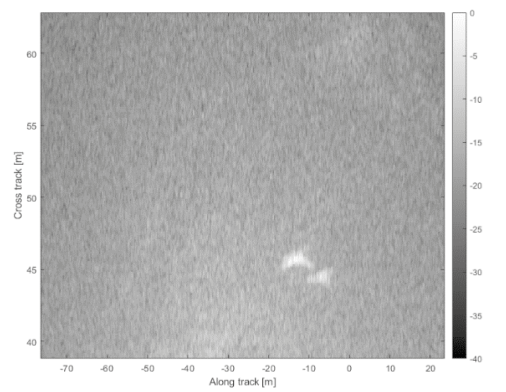
(b) POSEIDON system. The drone payload (EO/IR camera, radar sensors IMU system and GPS antenna) has been integrated successfully in the DJI matrice 600 pro

(C) First flight of the POSEIDON system to test the system integration and endurance before measurements



(d) Trials location and targets

(e) One of the performed Flights



(f) A SAR map of the target area

(g) Georeferenced radar target detections (red markers)

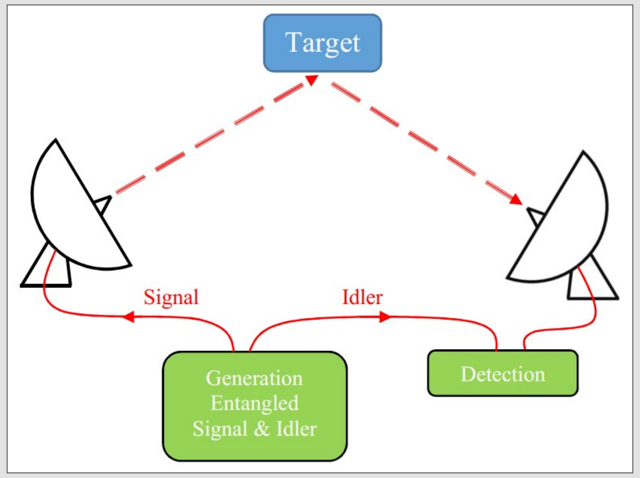
PROJECT QUANDO RF

Study on Quantum Technologies for RF Systems

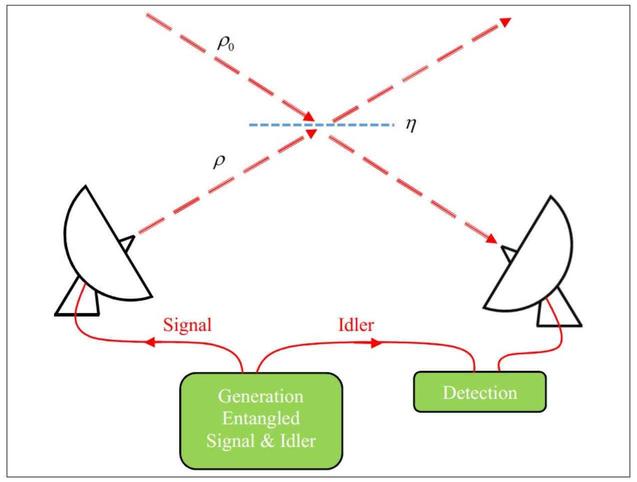
The First Quantum Revolution shaped the world we live in today: without mastering quantum physics, we could not have developed computers, telecommunications, satellite navigation, smartphones, or modern medical diagnostics.
Now a Second Quantum Revolution is unfolding, exploiting the enormous advancements in our ability to detect and manipulate "single quanta" (atoms, photons, electrons). The market availability of Quantum Sensors could lead to a paradigmatic shift in the design of future systems revolutionising Defence capabilities.
For the FWC QUANDO we assembled a consortium carefully structured to cover the entire value chain of innovation (from research organisations to innovative small and medium companies, including technology developers and integrators) with knowledge of state-of-the-art quantum sensing technologies and competences in military and defence applications.
To answer this novel service request, we have brought-in an additional subcontracting RTO with expertise in the application of quantum technologies to radar and surveillance systems.
As requested, we will perform a state-of-the-art analysis regarding quantum technology applications in the RF domain drawing on our consortium knowledge and expertise. Following we will concentrate on detection, tracking and recognition of challenging targets identifying and selecting the most promising quantum technologies. We will analyse the improvement brought about by these techniques with respect to naval based use cases. Building on our results from the FWC QUANDO we will assess common hardware and processing between quantumbased optronics and RF sensors. Our study will allow the definition of a clear roadmap for new project initiatives in both the field of RF sensor and optronics systems.

Technical Sheet
Funding institution:
EDA
Project partners
CNR, ONERA, TNO, FLYBY, HENSOLDT, LEONARDO, TECNOBIT, THALES, DLR, CNIT
Project duration
July 2021 - July 2022
Involved countries
Italy, France, Germany, Netherlands, Spain

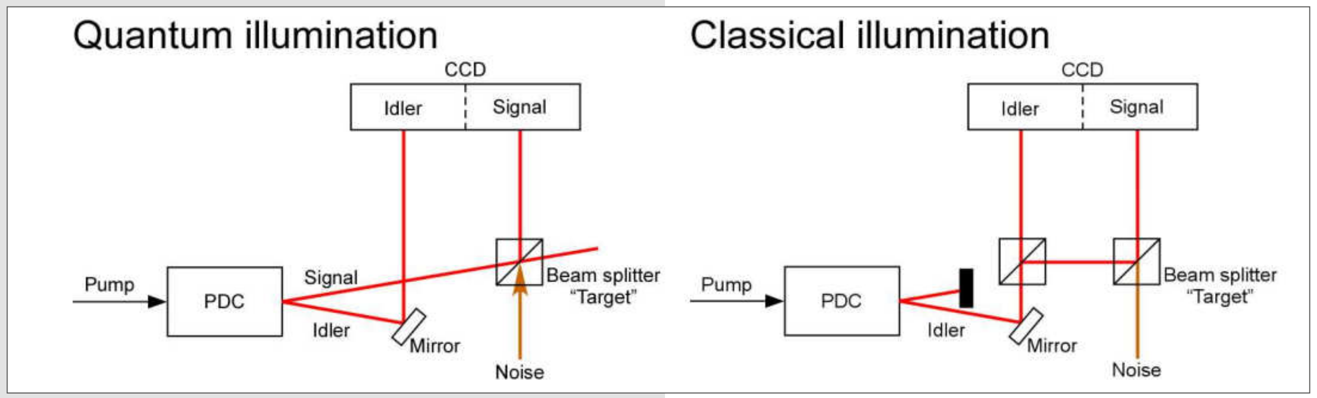
[3] M.Höijer, T. Hult and P. Jonsson, "Quantum Radar, a survey of the science, technology and literature". Technical report, December 2019, Swedish Defence Research Agency (FOI)



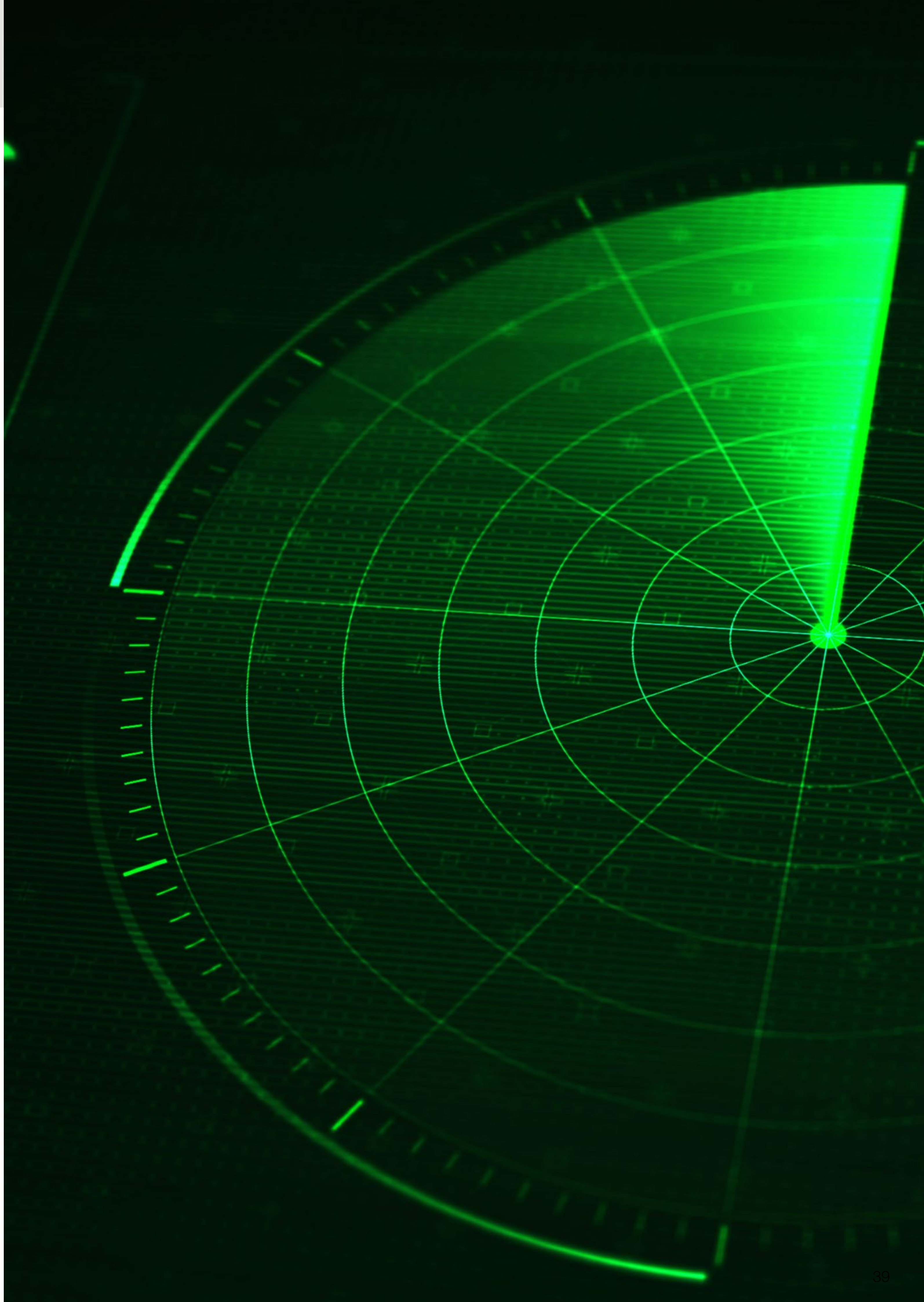
(a) Principal sketch of a quantum radar. The difference to a classical radar is the signal and idler being entangled. The entanglement creates an enhanced correlation between (the part of) the signal being reflected back and the idler [3]



b) A mathematical treatment of the quantum radar in (a) [3]



(c) The schematics of the setup used by Lopaeva et al. The signal and idler paths are arranged so they are equally long so the photons reach the CCD detector at the same time independently which path they took. CCD – charge-coupled device, PDC – parametric down-conversion [3].



PROJECT RING

3D Radar Imaging for Non-Cooperative Target Recognition

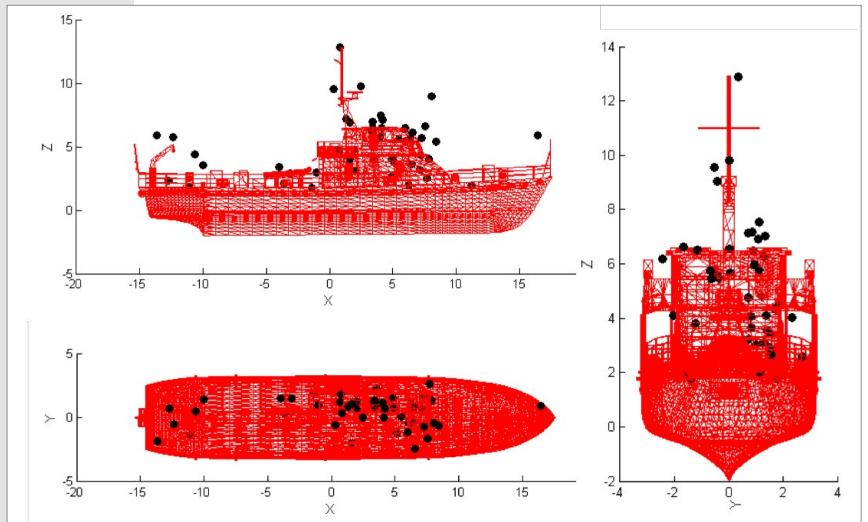
RING aims at developing a new system for Non-Cooperative Target Recognition (NCTR) based on 3D radar imaging. The core of this project is the development of a system for 3D radar image formation based on the use of a dual orthogonal baseline interferometric radar and the associated target recognition architecture and algorithms. The operative needs that have led to this proposal concern both tactical and strategic operations where target identification is a required capability. Use of this technology has also been considered in scenarios of civil/ homeland security.
State-of-the-art radar systems employ a basic target recognition system, which is based on an identification friend of foe (IFF) approach. This technology, though, is based on target's cooperation. Some modern systems employ noncooperative target recognition systems that are based on the use of 2D radar images, mainly Inverse Synthetic Aperture Radar (ISAR). 2D ISAR images, unfortunately, suffer of several issues, which may be overcome by employing 3D radar imaging technology. 3D information of a target, in fact, leads to a more refined target identification and prioritization for operational and tactical purposes. The precise target identification can be used for recognizing and prioritizing detected target. For example, the developed technology will provide vital information, including cases where it must be decided whether a detected target can be treated as an attacking plane, or whether it is fighter or bomber (with precise brand assignment), if it is armed (in case of externally attached missiles or bombs), and so on so forth. This project aims at developing and validating such technology to make it available to future radar systems.
The proposed technology could also be used in homeland security scenarios, in order to enhance maritime and border surveillance where it is important to recognize and classify detected targets. Examples are the protection of ports, airports, ships, critical infrastructures, coastal control, immigration monitoring and prevention, including maritime, air and space surveillance from different types of platforms (ground, naval, air and space). In all aforementioned applications, there is the need to recognize a threat produced by a non-cooperative target, which can be significantly enhanced by using recognition techniques based on a novel 3D radar imaging technology.
The project partners will develop three different demonstrator that will be tested during the third year of the project:

- A ground based interferometric radar system
- A Ship borne interferometric radar system
- A drone based interferometric radar system using 4 drones flying in formation.

During the second year of the RING project, we have realised the three technological demonstrators and developed algorithms for the recognition of non-cooperative targets that are based on 3D radar images. More specifically, two database-free approaches have been proposed that compare the 3D target reconstruction with the "reference" target saved in the system database. The first one directly compares the 3D target reconstruction with a target CAD model. The second one compares specific 2D views obtained from both the reference geometrical target model and the 3D target reconstruction.
Figure 1 shows an example of 3D InISAR reconstruction obtained by using a ground-based system previously developed by RaSS (2016).
Figures 2 and 3 illustrate the drone-based demonstrator main components.
Figure 4 shows an example of database-free classification

Technical Sheet
Funding institution:
MoD (IT)
Project partners
GEM, ECHOES, WUT, PIT-RADWAR
Project duration
January 2020 - October 2023
Involved countries
Italy, Poland

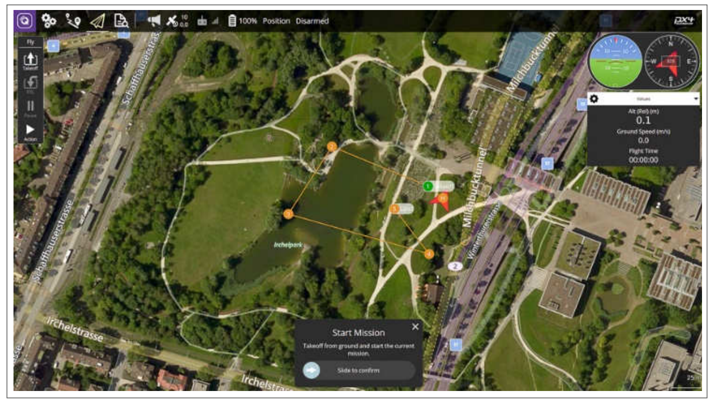
(a)The first ground based interferometric radar system developed at the RaSS laboratory in 2016 - PIRAD demonstrator



(b) An example of 3D InISAR results using real data acquired using PIRAD system. the results of the 3D InISAR is a cloud of point in the 3D space and is compared in this figure with the target CAD model;

(c) Drone selected for the drone-based demonstrator

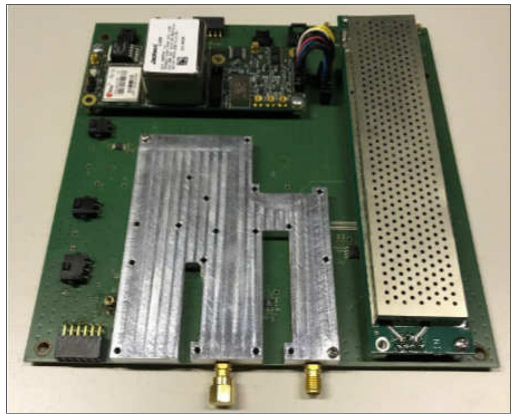
(d) Drone Futaba T10J radio controller;



(e) Drone Qground control software

(f) Radar antenna - 20dBi gain

(g) Radar digital component. It generates the waveform, acquires the receiving signals and communicates with the 4G router;

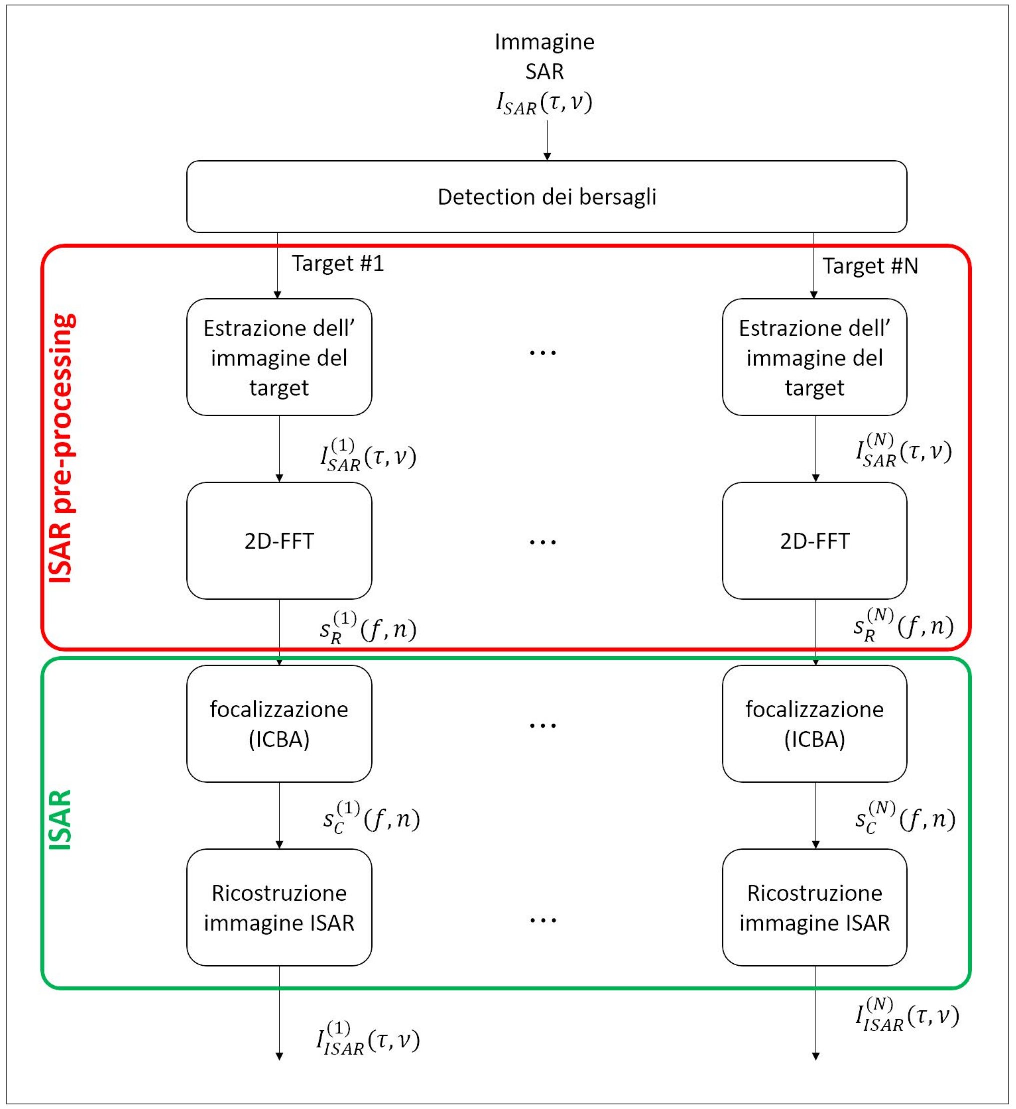


(h) Front-end module. It allows transmission of a LFMCW signal with a bandwidth of 600 MHz around 9.6 GHz;

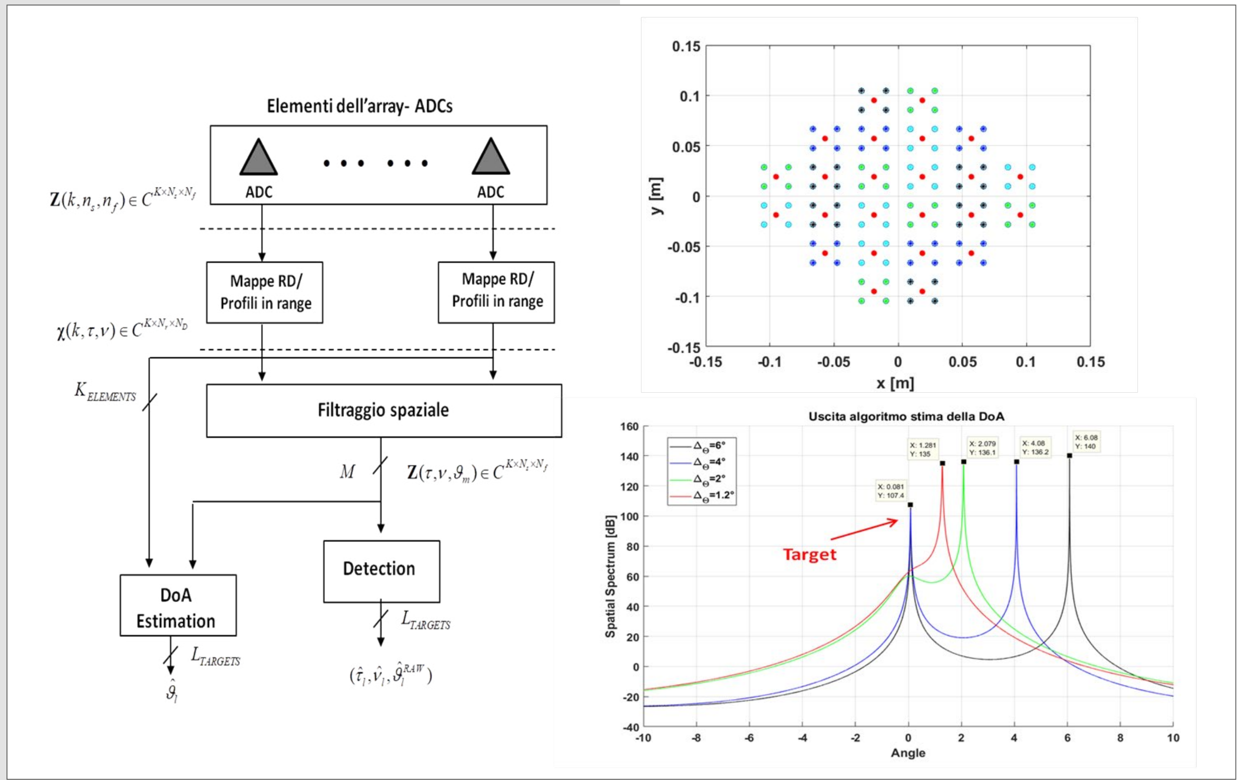
(i) Radar reference oscillator. Jackson Labs ULN-1100 GPSDO

Traditional seekers use a mechanical scanning antenna, which limits the overall system performance. With the improvement of the latest microwave device technologies, Active Electronic Scanned Array (AESA) has become implementable in seekers.
This allows for substantial performance improvements, which result in a significant increase of seeker's operational capabilities.
In particular, SAMBA-X aims to improve seeker's performances with regard to increased target discrimination, resistance to ECM (ECCM) and greater longevity thanks to the improved Mean Time Between Failure (MTBF) obtainable with this technology. In summary, this project focuses on the study and development, for the first time in Italy, of a low-cost seeker demonstrator equipped with an ITAR-free AESA X-band antenna. The seeker under consideration has multirole capabilities, that is, it could also be used as a fire direction system on smaller ships. As part of this project, a demonstrator based on AESA technology will be built and validated in laboratory. Such demonstrator will implement a digital version of the classic "monopulse".
The demonstrator will also be able to record "raw" data and make it available for offline verification of newly developed algorithms. Once validated, these algorithms will be available for future implementations (upgrades) either on the same demonstrator or on a possible, higher TRL, prototype.

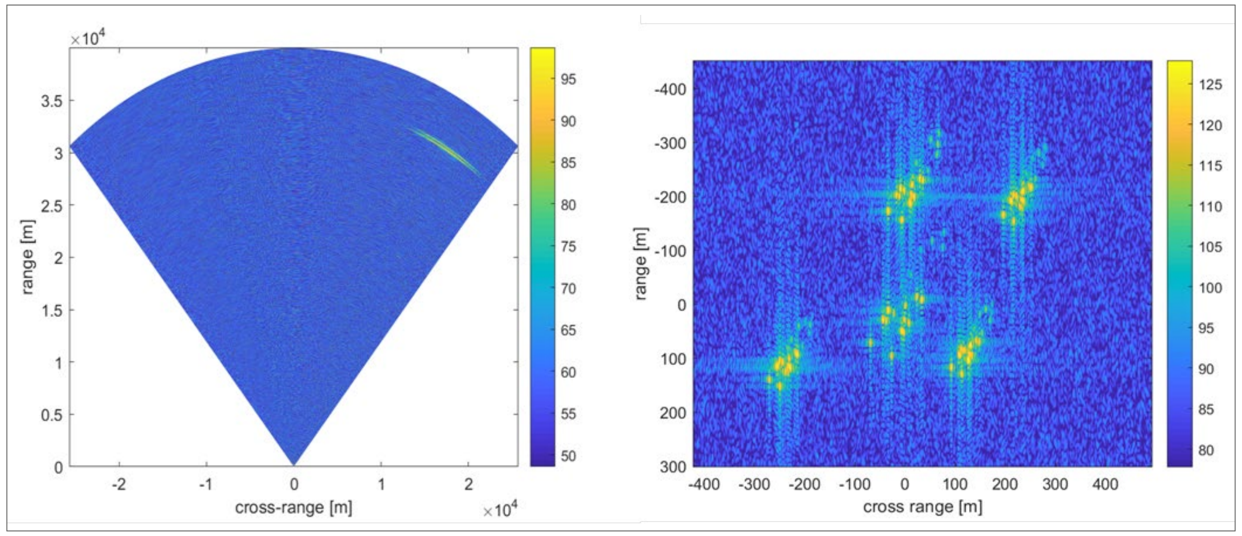
Technical Sheet
Funding institution:
Italian MoD
Project partners
ELDES s.r.l
Project duration
February 2020 - February 2022
Involved countries
Italy



(b) The block diagram of the ISAR algorithm applied to the SAR, also called "ISAR from SAR"



(a) Preliminary DBF architecture and results obtained by applying DBF on AESA antenna divided into sub-arrays



(c) Preliminary results on the radar imaging technique application

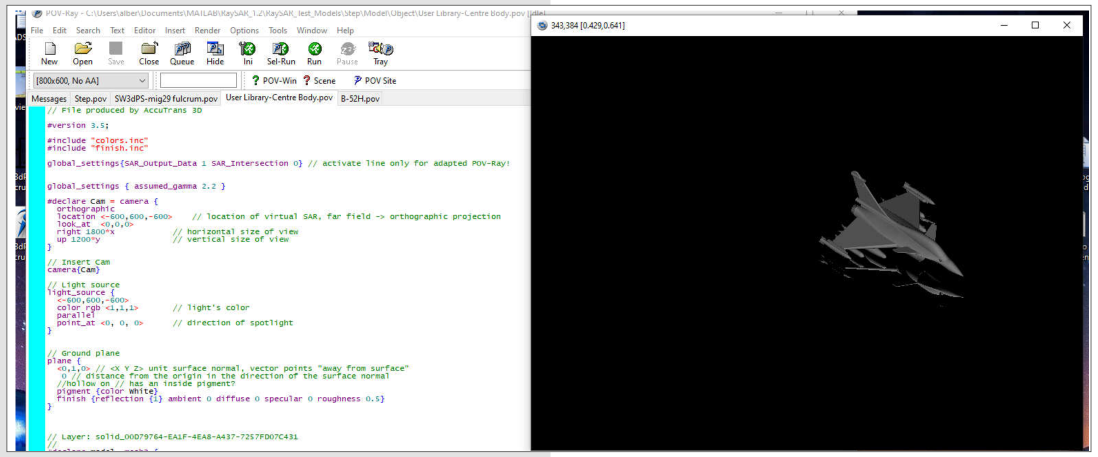
PROJECT SARAI

The objective of the project is to develop a simulated operating environment IMINT (Imagery Intelligence). This will be done through the formation of a multilevel deep learning network in order to “understand” the SAR images and time series by learning the functionalities without technical supervision and to carry out specific detection, classification and / or recognition tasks by specializing the technologies developed for the identified scenario. The objective of the activity is to support the execution of the tasks planned for Phase 1 of the SARAI project. In detail, the activity includes the following activities:
1. Task 1: Development, calibration and test of a SAR signature simulator with the following functions:

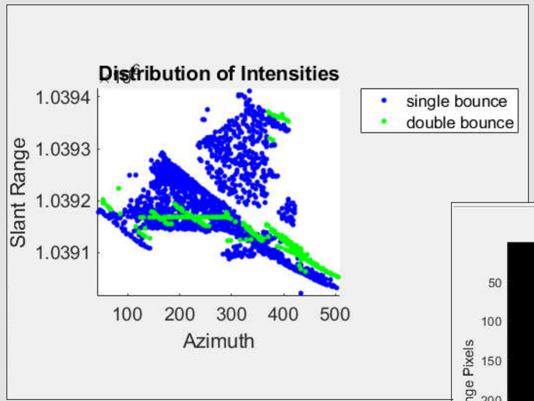
- Exploitation of 3D CAD geometric models characterizing the target and the surface where the target is located.
- Exploitation of the physical parameters characterizing the target materials (directly or indirectly through the definition of the diffusion and reflection coefficients).
- Modeling of the SAR backscattering mechanism including the geometric configuration and reflection parameters of the material.

2. • Task 2: Identification, selection and collection of 3D geometric models of the targets of interest both open source and from commercial suppliers.
3. • Task 3: Management, adaptation and conversion of 3D geometric models as input from the SAR simulator.
4. • Task 4: Generation of SAR signatures
5. • Task 5: Contribution to the project documentation relating to the SAR signature simulator.

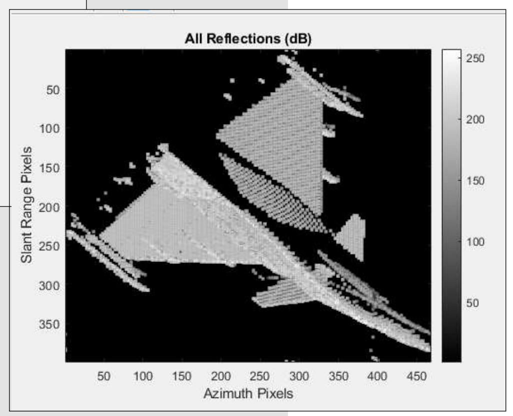
Technical Sheet
Funding institution:
E-GEOS S.p.a
Project partners
E-GEOS S.p.a
Project duration
February 2021 - February 2022
Involved countries
Italy



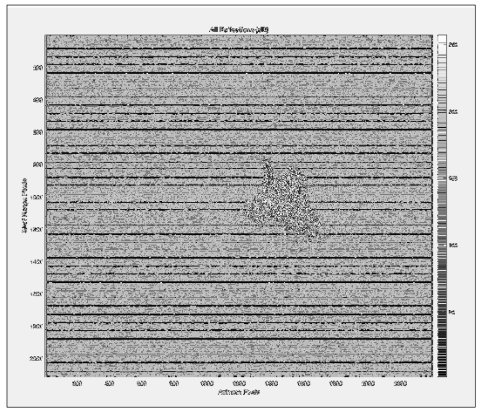
(a) Ray - raytracing simulation environment



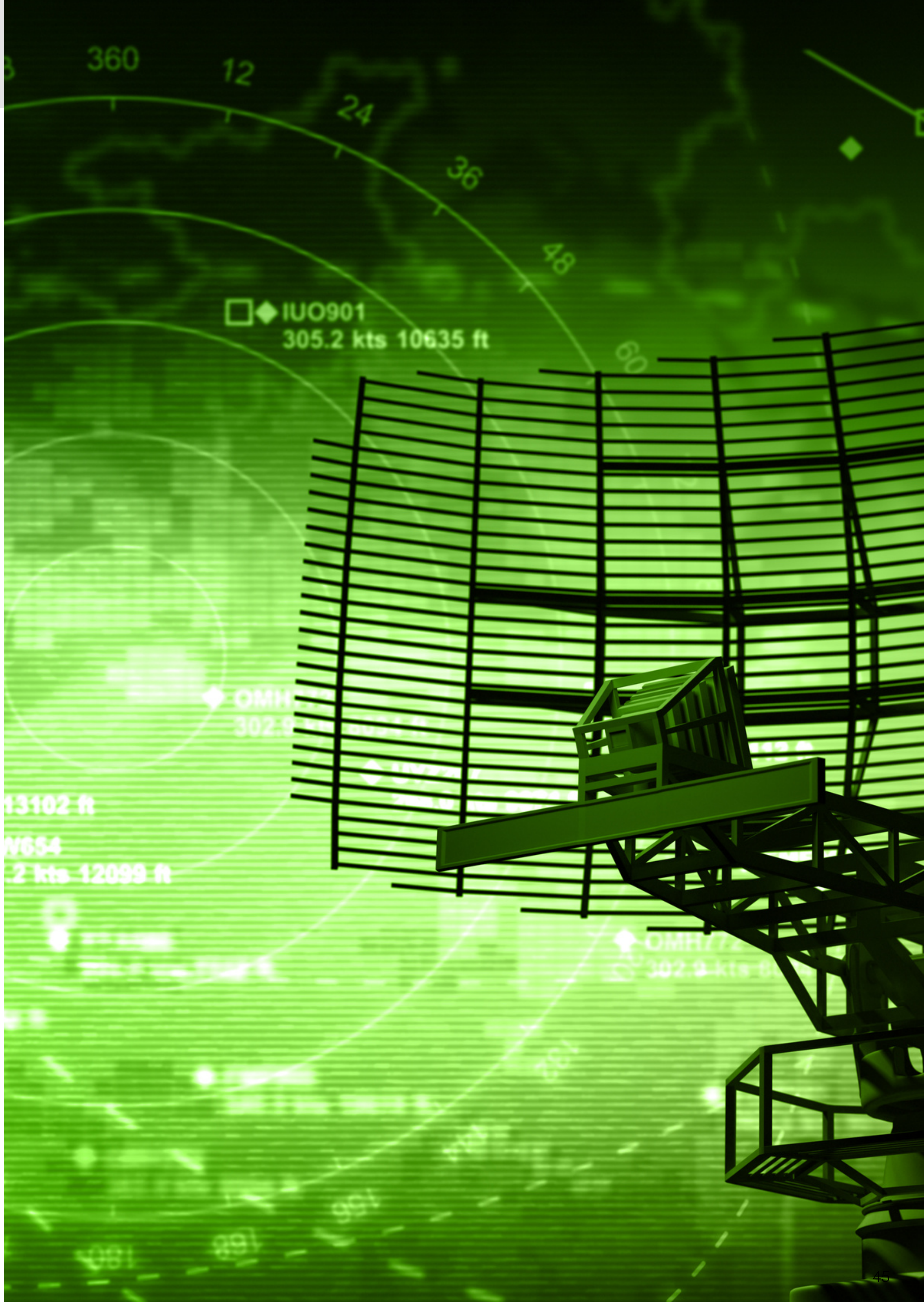
(b) Reflection behaviour after SAR image simulation



(c) Simulated intensity of SAR image

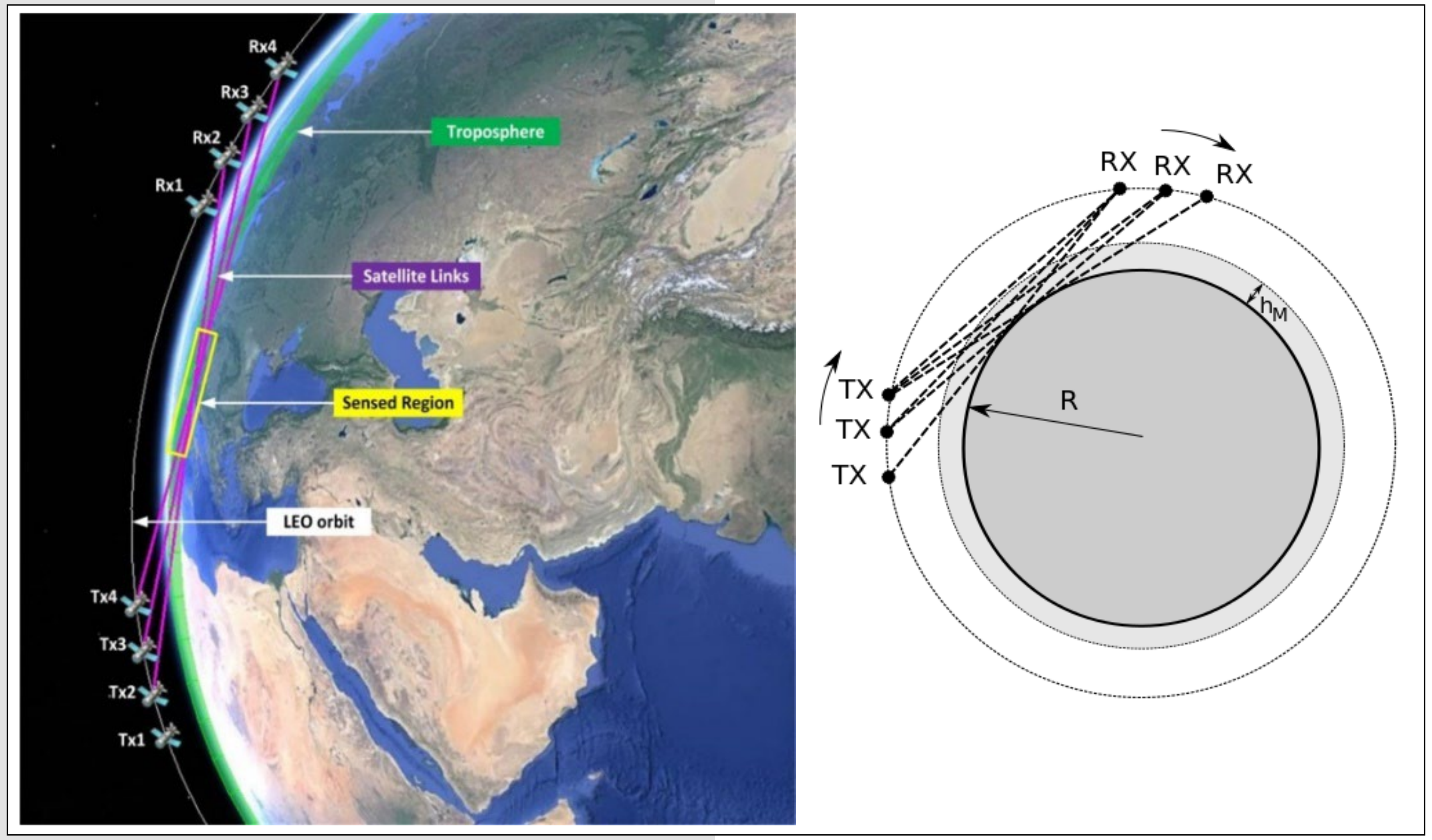


(d) Simulation of SAR image in presence of clutter

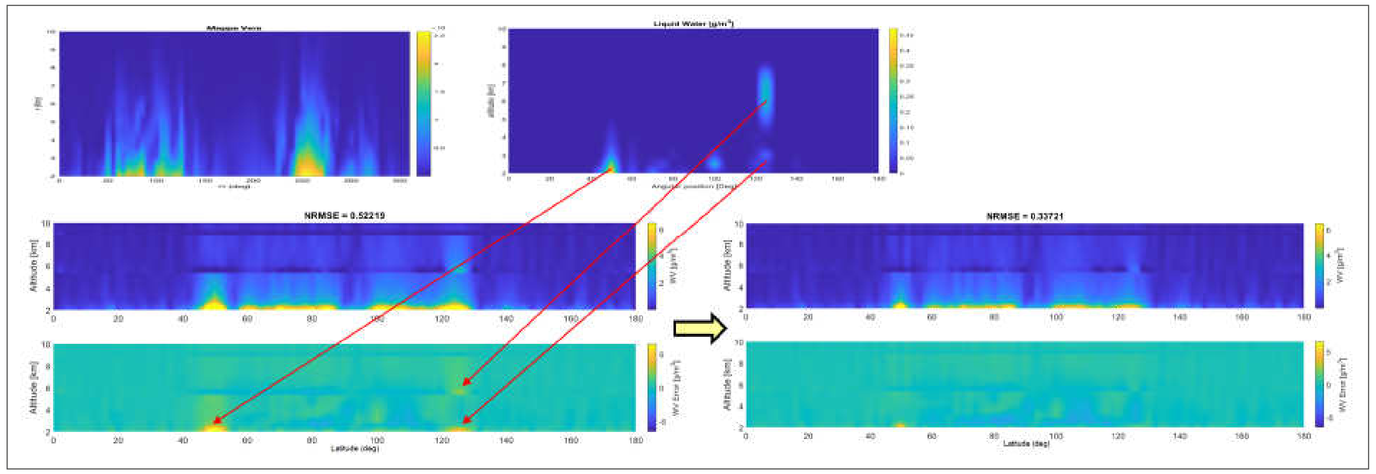


The CNIT researchers involved in the SATCROSS project have recently devised a method called NDSA (Normalized Differential Spectral Attenuation), which is useful for obtaining the integrated water vapor (IWV; Integrated Water Vapor) from a pair of attenuation measurements carried out in the microwave frequency range. In particular, NDSA has been shown to effectively estimate the IWV along the path between two Low Earth Orbit (LEO) satellites - one carrying a transmitter and the other a receiver - in a limb measurement geometry, using frequencies of transmission in the Ku and K frequency bands (and even higher in the case of the higher tropospheric layers).
The NDSA method is based o measuring a parameter called "spectral sensitivity" which is the normalized incremental ratio of the spectral attenuation and was found to be linearly related to the IWV along the path between the two LEO satellites. The SATCROSS project aims at providing a pre-feasibility study for a space remote sensing system based on a train of LEO satellites orbiting in the same plane and along the same direction (configuration of co-rotating satellites). In such a configuration, in which one or more LEO satellites with an on-board transmitter follow(s) one or more LEO satellites with a receiving apparatus, the NDSA measurements (and consequently the resulting IWV estimates) refer to links that cross the troposphere at certain altitudes predetermined by the Earth, connections that in this way "brush" an entire annular region in the orbital plane. It is thus possible to estimate the two-dimensional field of water vapor in the aforementioned annular region starting from the entire set of IWV measurements based on an inverse problem formulation. Such a remote sensing system will be able to recover two-dimensional water vapor fields on vertical sections of the troposphere on a continuous time basis. A NDSA demonstrator was built and installed for a measurement campaign started in August 2021.

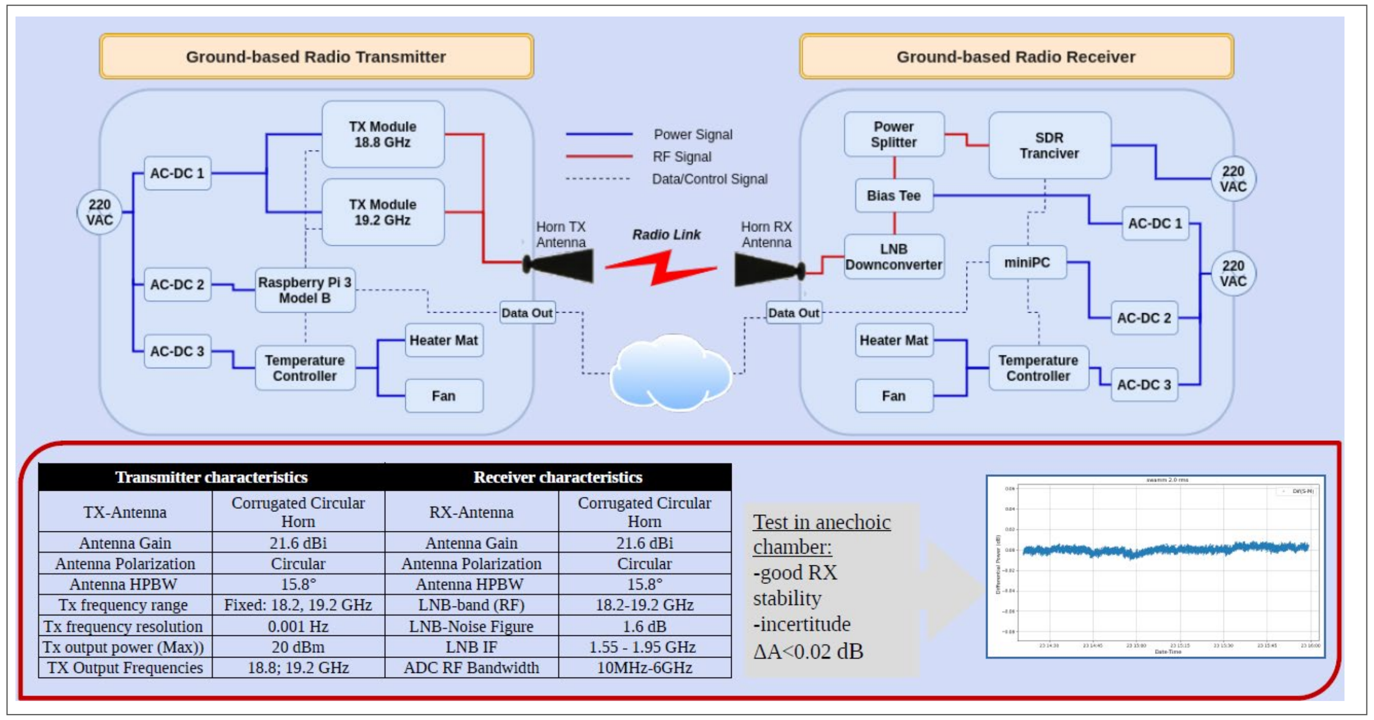
Technical Sheet
Funding institution:
ASI
Project partners
Lamma, Picosats s.r.l.
Project duration
March 2020 - March 2022
Involved countries
Italy



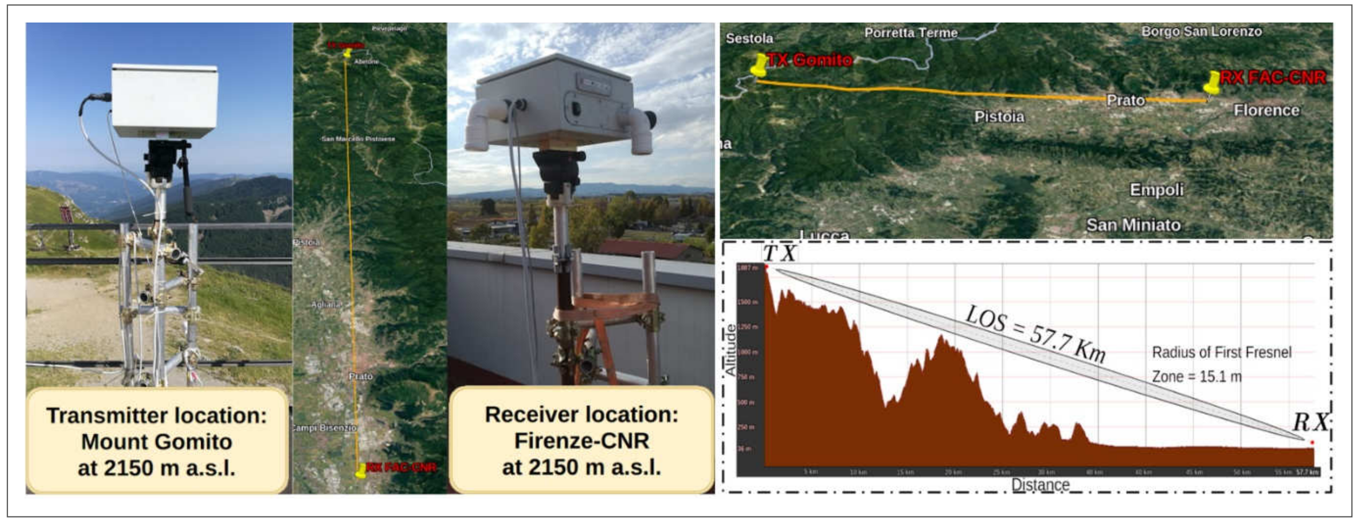
(a) Measurement configuration scheme © [2016] IEEE. Reprinted, with permission, from [A. Lapini et al., "The Normalized Differential Spectral Sensitivity Approach Applied to the Retrieval of Tropospheric Water Vapor Fields Using a Constellation of Corotating LEO Satellites," in IEEE Transactions on Geoscience and Remote Sensing, vol. 54, no. 1, 2016];



(b) Detection of the presence of liquid water along the microwave links and correction of the effects on the WV estimates using an additional NDSA channel at 32 GHz. Upper left panel: WV field; upper right panel: liquid water field; lower left panel: retrieved WV field with the effects of liquid water and related error field ; lower right panel: retrieved WV field after correction of the error due to liquid water and related error field © [2016] IEEE. Reprinted, with permission, from [A. Lapini et al., "The Normalized Differential Spectral Sensitivity Approach Applied to the Retrieval of Tropospheric Water Vapor Fields Using a Constellation of Corotating LEO Satellites," in IEEE Transactions on Geoscience and Remote Sensing, vol. 54, no. 1, 2016].;



(c) The SATCROSS NDSA demonstrator: schematic description of the Tx/Rx systems;



d) The SATCROSS NDSA demonstrator: installation setup for the experimental campaign started in August 2021

PROJECT SMARTAESA

Scalable & Multifunction SW defined RADAR and fuTure AESA

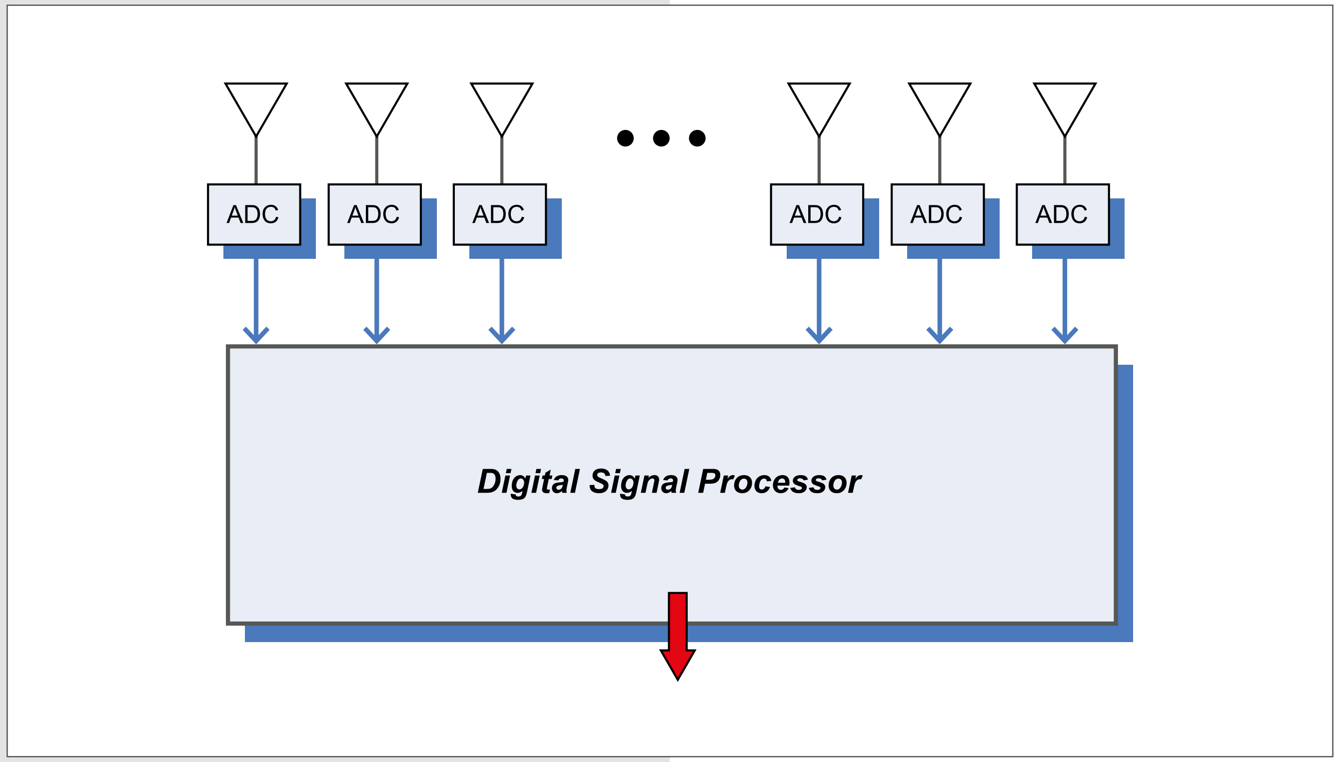
The objectives of this project are:

1. Study and design of a full digital beamforming radar architecture for open and SW defined multifunction radars. As a case in point, for design purposes only, a radar type MAESA-L, therefore in L band (1 GHz - 2 GHz) and with about a thousand transceiver channels will be considered.
2. The realization of an L-band demonstrator, scaled and of suitable geometry, which uses the full digital beamforming techniques and with the aim of carrying out surveillance activities of appropriate scenarios of interest.

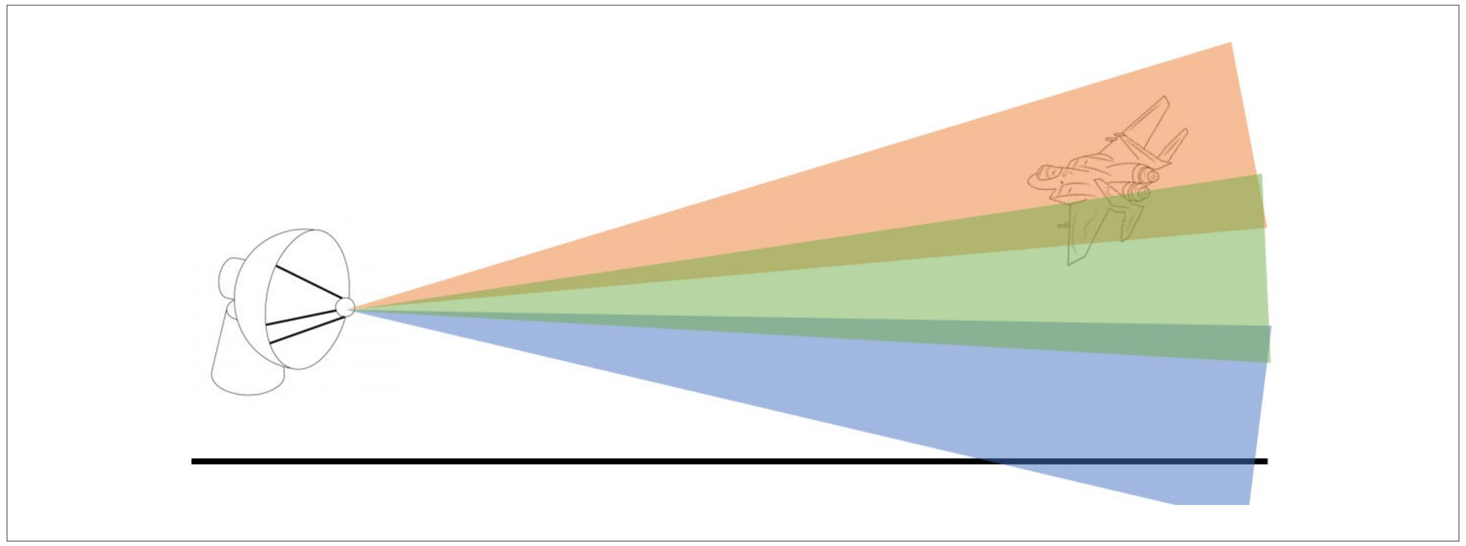
The proposed architecture will have characteristics of scalability, flexibility and adaptability that will allow future multifunction radar systems that will be based on it to:

- Avoid becoming rapidly obsolete with respect to the evolution of the threats they must counter.
- Be easily improved / upgradeable by means of firmware / software upgrades (e.g. implementation of accessory functions and / or the implementation of advanced signal processing based on Artificial Intelligence algorithms).

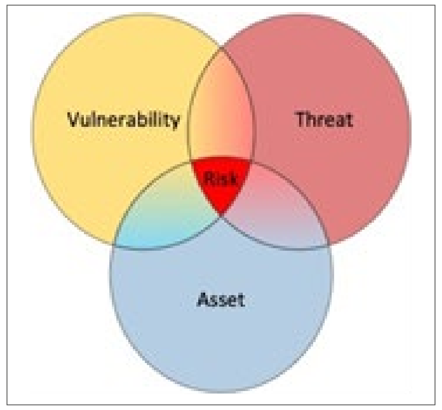
Technical Sheet
Funding institution:
Italian MoD
Project partners
Leonardo spa, Echoes srl
Project duration
April 2020 - April 2023
Involved countries
Italy



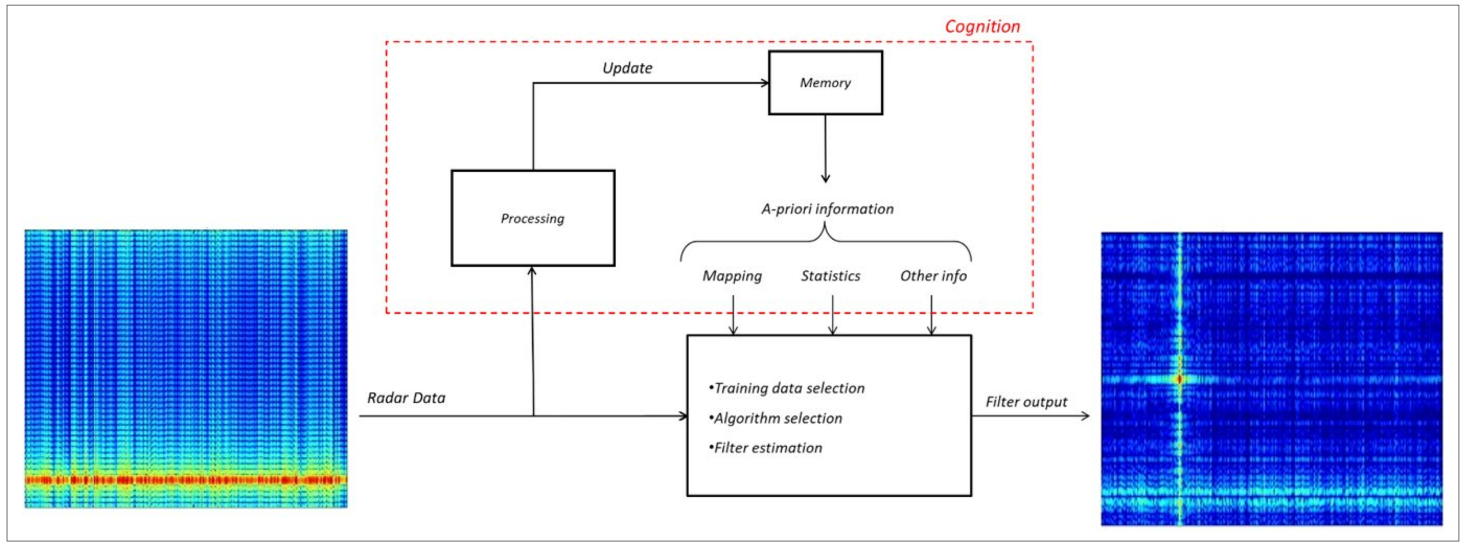
(a) Digital Array Radar Architecture



(b) Simulated multiple fan-beam geometries



(c) Cyber risk concept representation



(d) High level block diagram of the cognitive adaptive filter

PROJECT SPIA

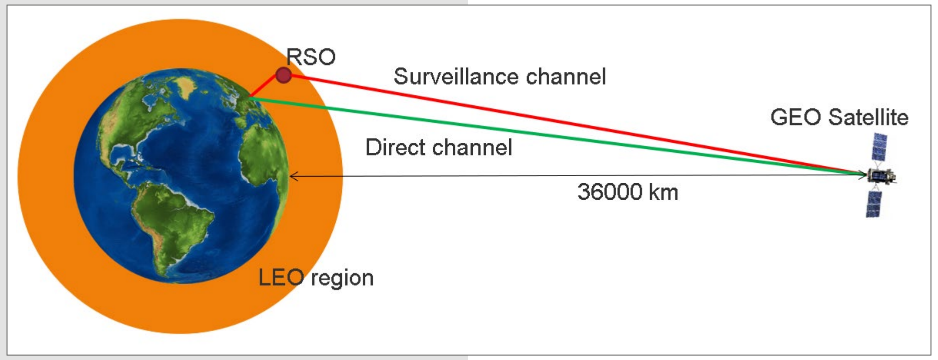
Passive radar system for the detection of low-Earth orbit objects

The proposed technological solution is focused on the use of a passive radar based on an array antenna that uses signals transmitted from satellite platforms (e.g.: DVB-S/DVB-S2) as illuminators of opportunity. This approach represents an opportunity of particular interest for the detection of space debris, thanks to the very wide coverage that transmitters in geostationary orbit can guarantee. The passive radar architecture allows for continuous surveillance (24 hours on 7 days), without the use of any own transmitters, minimizing costs and energy consumption. In order to improve the radar detection performance, we propose the adoption of an array antenna formed by a high number of receive-only elements, therefore limiting the realization costs. Moreover, a single receiving element will be equipped with a flexible reception system capable of digitizing high-bandwidth signals. The ability to acquire broadband signals will allow the system to exploit a large part of the energy radiated by the satellite in order to improve the level of SNR.
The use of an array of antennas and digital beamforming techniques can enable the achievement of a sufficient gain and the possibility to scan electronically the volume under surveillance.

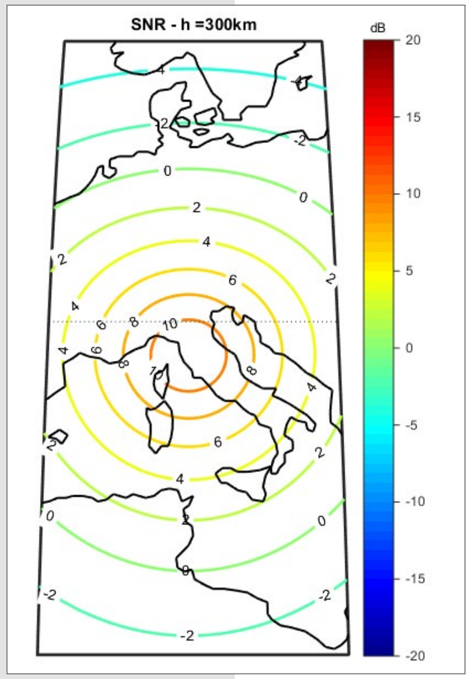
The main objectives of the Phase 1 (first year) of the project are:

- Definition of system requirements;
- Study and definition of the receiver antenna array geometry configuration;
- Study and definition of digital beamforming techniques;
- Study and definition of the signal processing system.

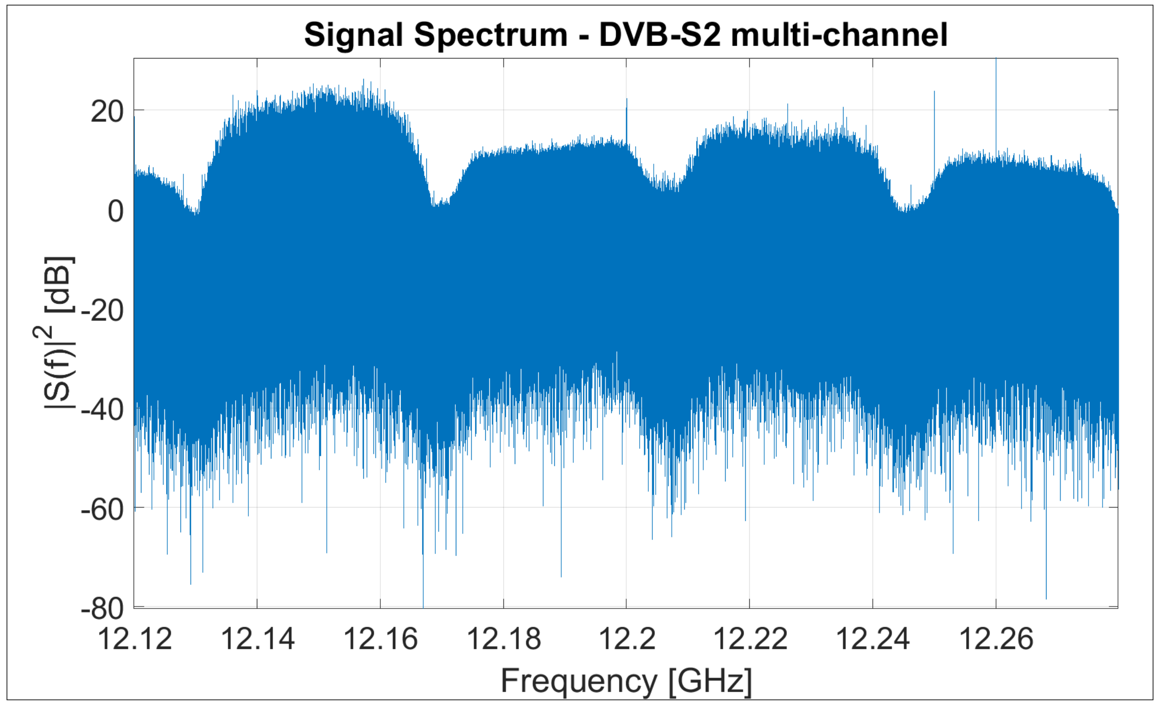
Technical Sheet
Funding institution:
Italian MoD
Project partners
ECHOES S.r.l.
Project duration
February 2020 - November 2020
Involved countries
Italy



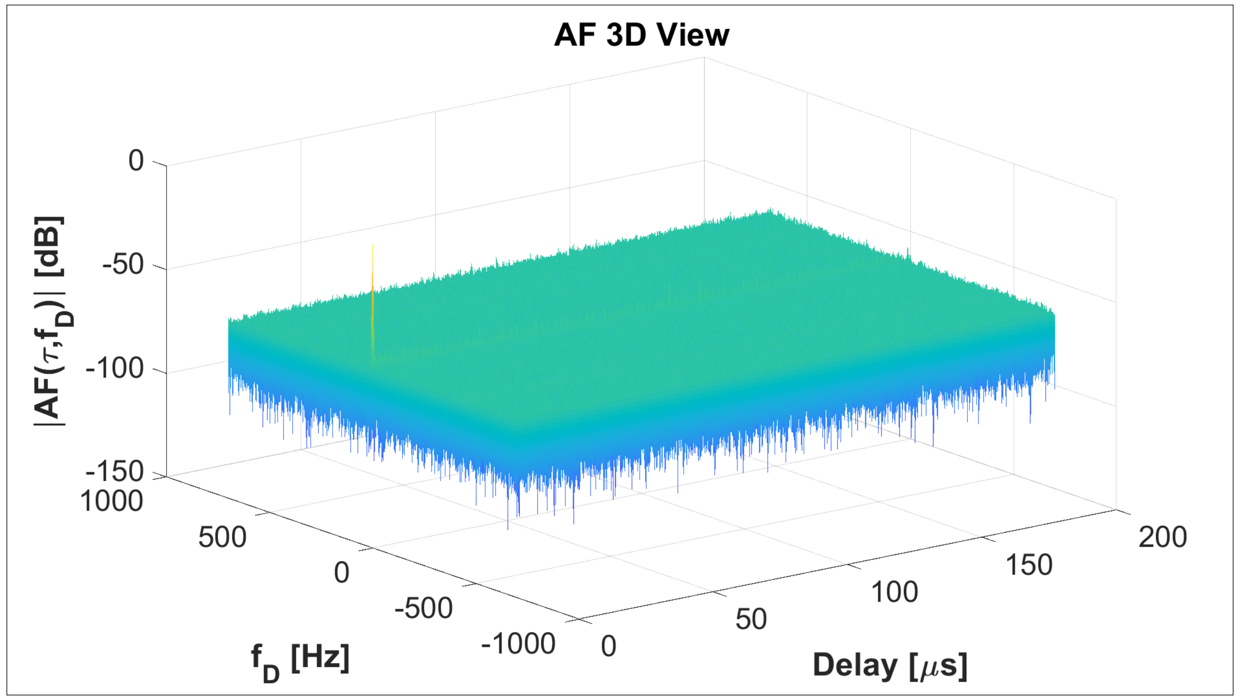
(a) Geometry of a satellite-based passive bistatic radar © [2020] IEEE. Reprinted, with permission, from [L. Gentile, A. Capria, A. L. Saverino, Z. Hajdaraj and M. Martorella, "DVB-S2 Passive Bistatic Radar for Resident Space Object detection: preliminary results," 2020 IEEE International Radar Conference (RADAR), 2020];



(b) Expected SNR map obtained for a target with RCS=20 dBsm at an height=300 km



(c) Measured signal spectrum containing four transponders (Eutelsat Hotbird 13B real data)



(d) Four transponders DVB-S/DVB-S2 AF as a function of time delay and Doppler frequency (Eutelsat Hotbird 13B real data);

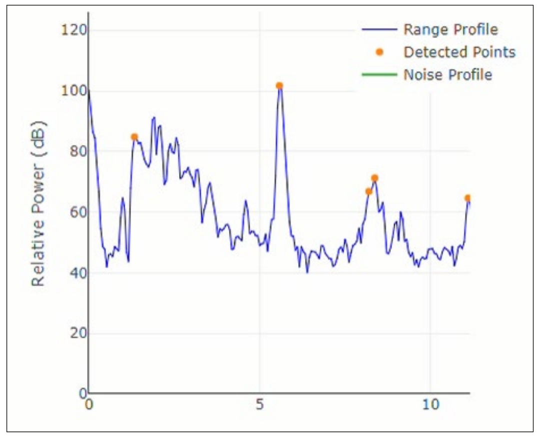
PROJECT WATER4AGRIFOOD

The water crisis: Global warming is the cause of climate change, weather anomalies and reduced rainfall. Over the last 50 years, the Mediterranean area has lost 100 millilitres of water per year.
Agriculture in distress: The unpredictability of the rains is putting agriculture, especially rainfed agriculture that relies solely on rainwater, in crisis. The risk is that it will not be possible to ensure water in quantity and quality to the agri-food chain.
No agrifood without water. Global warming is the cause of climate change which, in turn, leads to weather anomalies that we can all experience. What we observe is the unpredictability of rainfall. Without effective rainfall, it is not possible to ensure water in quantity and quality to the agri-food chain.
The project was set up to understand how to use and exploit water in farming systems in the South.
Public research bodies and private companies have formed a partnership to finalise industrial research actions and experimental development insights to innovate the use of water in farms from which the raw materials for the agri-food chains originate. Possible solutions: It is urgent to find a remedy, or rather a range of solutions. A sort of tool box in which to choose the most suitable tool for farms.
Improving Mediterranean agri-food production under conditions of water scarcity seeks to find a solution to the problem of the lack of water available to farms and, more generally, to highlight its value for production purposes.

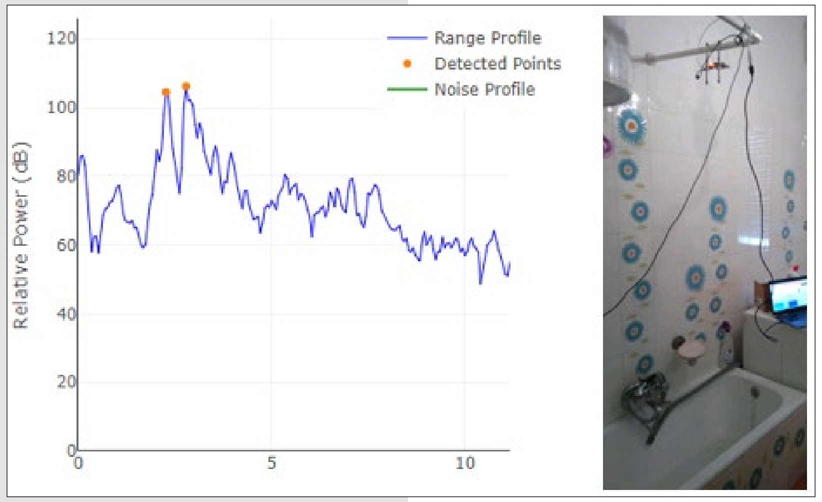
(a) Signal acquired in real environment (irrigation channel)

The Water4Agrifood project brings together expertise from industry and academic knowledge to build the right tools to make the best use of the water resources available to farms.
Regarding the development of sensors and data processing techniques for the remote monitoring of the geometry and water levels of the irrigation canal network, CNIT-RaSS performs the analysis and measurements acquired with a radar demonstrator exploiting some car-maker's hardware.

Technical Sheet
Funding institution:
Progetto Codice ARS01_00825 - Area di Specializzazione "Agrifood", PON R&I 2014-2020 e FSC
Project partners
UniCT-Di3A, Suez, Planeta, Irritec, CREA, ISEA, Tecno.El, CER, Polyeur, CNIT, Bonifiche Ferraresi, Agriservice.
Project duration
November 2020 - May 2023
Involved countries
Italy



(b) Signal received. The central peak in orange corresponds to the power received from the water surface, the power peaks on the left correspond to the power received from the grassy bank



(c) Signal received in a controlled environment during Covid-19 lockdown. (Water inside a tank). The two peaks marked in orange represent the power received from the water surface (peak on the right) and the power received from the edge of the tank (peak on the left)

PUBLICATIONS

2021

[1] Brüggenwirth S, Wagner S, Bieker T, Battisti N, Rispoli V, Greco M, Pinelli G, Cataldo D and Martorella M (2021). "Results on Super-Resolution and Target Identification Techniques from the SPERI Project" IEEE Aerospace and Electronic Systems Magazine. 36(3), 24-35. ISSN: [DOI] [URL]

[2] Brizi D, Zhang S, Liu J, Cui Y and Monorchio A (2021). "A Circuital Approach to Control the Response of Conformal Metasurfaces" 2021 34th General Assembly and Scientific Symposium of the International Union of Radio Science, URSI GASS 2021. ISSN: [DOI] [URL]

[3] Brizi D and Monorchio A (2021). "An analytical approach for the arbitrary control of magnetic metasurfaces frequency response" IEEE Antennas and Wireless Propagation Letters. 20(6), 1003-1007. ISSN: [DOI] [URL]

[4] Brizi D, Fontana N and Monorchio A (2021). "Analytical Approach for MRI RF Array Coils Decoupling by Using Counter-Coupled Passive Resonators" IEEE Open Journal of Antennas and Propagation. 2, 249-258. ISSN: [DOI] [URL]

[5] Cai J, Martorella M, Chang S, Liu Q, Ding Z and Long T (2021). "Efficient Nonparametric ISAR Autofocus Algorithm Based on Contrast Maximization and Newton's Method" IEEE Sensors Journal. 21(4), 4474-4487. ISSN: [DOI] [URL]

[6] Cai J, Martorella M, Liu Q, Giusti E and Ding Z (2021). "The alignment problem for 3D ISAR imaging with real data" Proceedings of the European Conference on Synthetic Aperture Radar, EUSAR. 2021-March, 46-51. ISSN: [URL]

[7] Canicatti E, Giampietri E, Brizi D, Fontana N and Monorchio A (2021). "A Numerical Exposure Assessment of Portable Self-Protection, High-Range, and Broadband Electromagnetic Devices" IEEE Open Journal of Antennas and Propagation. 2, 555-563. ISSN: [DOI] [URL]

[8] Cantelli-Forti A, Capria A, Saverino A, Berizzi F, Adami D and Callegari C (2021). "Critical infrastructure protection system design based on SCOUT multitech seCurity system for intercOnnected space control groUnd staTions" International Journal of Critical Infrastructure Protection. 32 ISSN: [DOI] [URL]

[9] Conte M, Giampietri E, Brizi D and Monorchio A (2021). "A High-Impedance Surface for Improving Performance of Microwave Imaging Antennas for Biomedical Applications" 2021 34th General Assembly and Scientific Symposium of the International Union of Radio Science, URSI GASS 2021. ISSN: [DOI] [URL]

[10] DIana S, Brizi D, Ciampalini C, Nenna G and Monorchio A (2021). "A Compact Double-Ridged Horn Antenna for Ultra-Wide Band Microwave Imaging" IEEE Open Journal of Antennas and Propagation. 2, 738-745. ISSN: [DOI] [URL]

[11] Fontana N, Brizi D, Barmada S, Raugi M and Monorchio A (2021). "Optimization and Robustness Analysis of a Spiral Resonators Array for Misalignment Recovering purposes in WPT Systems" 2021 34th General Assembly and Scientific Symposium of the International Union of Radio Science, URSI GASS 2021. ISSN: [DOI] [URL]

[12] Ghio S, Martorella M, Staglianò D, Petri D, Lischi S and Massini R (2021). "Experimental comparison of radon domain approaches for resident space object's parameter estimation" Sensors (Switzerland). 21(4), 1-13. ISSN: [DOI] [URL]

[13] Ghio S and Martorella M (2021). "Size estimation of space debris models from their RCS measured in anechoic chamber" EuRAD 2020 - 2020 17th European Radar Conference. , 421-424. ISSN: [DOI] [URL]

[14] Giusti E, Capria A and Martorella M (2021). "Target-borne ECM against OFDM-based Imaging Passive Radars" EuRAD 2020 - 2020 17th European Radar Conference. , 136-139. ISSN: [DOI] [URL]

[15] Giusti E, Ghio S and Martorella M (2021). "Drone-based 3D interferometric ISAR Imaging" IEEE National Radar Conference - Proceedings. 2021-May ISSN: [DOI] [URL]

[16] Lang P, Fu X, Martorella M, Dong J, Qin R, Feng C and Zhao C (2021). "RRSARNet: A Novel Network for Radar Radio Sources Adaptive Recognition" IEEE Transactions on Vehicular Technology. ISSN: [DOI] [URL]

[17] Martorella M, Gelli S and Bacci A (2021). "Ground moving target imaging via sdap-isar processing: Review and new trends" Sensors. 21(7) ISSN: [DOI] [URL]

[18] Mishra V, Costa F, Zhang S, Liu J, Cui Y and Monorchio A (2021). "Analysis of Radome Structures Placed in the Near-Field of Antennas" 2021 34th General Assembly and Scientific Symposium of the International Union of Radio Science, URSI GASS 2021. ISSN: [DOI] [URL]

[19] Montomoli F, Macelloni G, Facheris L, Cuccoli F, Bianco S, Gai M, Cortesi U, Natale G, Toccafondi A, Puggelli F, Antonini A, Volpi L, Dei D, Grandi P, Mariottini F and Cucini A (2021). "Integrated Water Vapor Estimation Through Microwave Propagation Measurements: First Experiment on a Ground-to-Ground Radio Link" IEEE Transactions on Geoscience and Remote Sensing. ISSN: [DOI] [URL]

[20] Oveis A, Martorella M, Sebt M and Noroozi A (2021). "Enhanced Azimuth Resolution in Synthetic Aperture Radar Using the MUSIC Algorithm" EuRAD 2020 - 2020 17th European Radar Conference. , 140-143. ISSN: [DOI] [URL]

[21] Oveis A, Giusti E, Ghio S and Martorella M (2021). "CNN for Radial Velocity and Range Components Estimation of Ground Moving Targets in SAR" IEEE National Radar Conference - Proceedings. 2021-May ISSN: [DOI] [URL]

[22] Rotundo S, Brizi D and Monorchio A (2021). "A Feasibility Study for Cracks Detection in Metallic Prosthetic Implants by Radio-Frequency Coils" 2021 34th General Assembly and Scientific Symposium of the International Union of Radio Science, URSI GASS 2021. ISSN: [DOI] [URL]

2020

[1] Bersaglia M, Norouzian F, Hoare E, Martorella M and Cherniakov M (2020). "Effect of Volume Distributed Clutter in PSK Modulated Automotive Radar" IEEE National Radar Conference - Proceedings. 2020-September ISSN: [DOI] [URL]

[2] Brizi D, Stang J, Monorchio A and Lazzi G (2020). "A Compact Magnetically Dispersive Surface for Low-Frequency Wireless Power Transfer Applications" IEEE Transactions on Antennas and Propagation. 68(3), 1887-1895. ISSN: [DOI] [URL]

[3] Brizi D, Fontana N, Giovannetti G, Menichetti L, Cappiello L, Doumett S, Ravagli C, Baldi G and Monorchio A (2020). "A Radiating System for Low-Frequency Highly Focused Hyperthermia with Magnetic Nanoparticles" IEEE Journal of Electromagnetics, RF and Microwaves in Medicine and Biology. 4(2), 109-116. ISSN: [DOI] [URL]

[4] Brizi D, Fontana N, Costa F, Tiberi G, Galante A, Alecci M and Monorchio A (2020). "Design of Distributed Spiral Resonators for the Decoupling of MRI Double-Tuned RF Coils" IEEE Transactions on Biomedical Engineering. 67(10), 2806-2816. ISSN: [DOI] [URL]

[5] Brizi D, Stang J, Monorchio A and Lazzi G (2020). "On the Design of Planar Arrays of Nonresonant Coils for Tunable Wireless Power Transfer Applications" IEEE Transactions on Microwave Theory and Techniques. 68(9), 3814-3822. ISSN: [DOI] [URL]

[6] Brizi D, Fontana N, Tucci M, Barmada S and Monorchio A (2020). "A Spiral Resonators Passive Array for Inductive Wireless Power Transfer Applications with Low Exposure to near Electric Field" IEEE Transactions on Electromagnetic Compatibility. 62(4), 1312-1322. ISSN: [DOI] [URL]

[7] Brizi D, Fontana N, Barmada S and Monorchio A (2020). "Spiral Resonators Array in inductive Wireless Power Transfer Applications: An Equivalent Lumped Circuit Retrieval Method" 2020 33rd General Assembly and Scientific Symposium of the International Union of Radio Science, URSI GASS 2020. ISSN: [DOI] [URL]

[8] Brizi D, Fontana N, Canicatti E, Giampietri E and Monorchio A (2020). "On the Specific Absorption Rate Behavior of Square-wave Modulated Signals Exposures" 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 - Proceedings. , 1559-1560. ISSN: [DOI] [URL]

[9] Brizi D, Fontana N, Costa F, Matera R, Tiberi G, Galante A, Alecci M and Monorchio A (2020). "Design of Distributed Spiral Resonators for the Decoupling of MRI Array Coils" 14th European Conference on Antennas and Propagation, EuCAP 2020. ISSN: [DOI] [URL]

[10] Brizi D, Fontana N, Costa F, Tiberi G, Galante A, Alecci M and Monorchio A (2020). "Design of a 7 T Spiral Resonator-Based Filter for MRI Planar Array Coupling Reduction" 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 - Proceedings. , 57-58. ISSN: [DOI] [URL]

[11] Cai J, Martorella M, Liu Q, DIng Z, Giusti E and Long T (2020). "Automatic Target Recognition Based on Alignments of Three-Dimensional Interferometric ISAR Images and CAD Models" IEEE Transactions on Aerospace and Electronic Systems. 56(6), 4872-4888. ISSN: [DOI] [URL]

[12] Canicatti E, Brizi D, Monorchio A, Fontana N and Tiberi G (2020). "Dielectric Characterization of Biological Samples by Using an Open-ended Coaxial Probe" 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 - Proceedings. , 639-640. ISSN: [DOI] [URL]

[13] Cantelli-Forti A and Colajanni M (2020). "Digital Forensics in Vessel Transportation Systems" Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics). 12056 LNCS, 354-362. ISSN: [DOI] [URL]

[14] Cataldo D, Gentile L, Ghio S, Giusti E, Tomei S and Martorella M (2020). "Multibistatic Radar for Space Surveillance and Tracking" IEEE Aerospace and Electronic Systems Magazine. 35(8), 14-30. ISSN: [DOI] [URL]

[15] Cuccoli F, Facheris L, Antonini A, Melani S and Baldini L (2020). "Weather radar and rain-gauge data fusion for quantitative precipitation estimation: Two case studies" IEEE Transactions on Geoscience and Remote Sensing. 58(9), 6639-6649. ISSN: [DOI] [URL]

[16] Diana S, Ciampalini C, Nenna G, Brizi D and Monorchio A (2020). "Design and implementation of a compact Double Ridged Horn Antenna for Ultra-Wide band Microwave Imaging" 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 - Proceedings. , 133-134. ISSN: [DOI] [URL]

[17] Fantasia M, Galante A, Maggiorelli F, Retico A, Fontana N, Monorchio A and Alecci M (2020). "Numerical and Workbench Design of 2.35 T Double-Tuned (1H/23Na) Nested RF Birdcage Coils Suitable for Animal Size MRI" IEEE Transactions on Medical Imaging. 39(10), 3175-3186. ISSN: [DOI] [URL]

[18] Fontana N, Brizi D, Barmada S and Monorchio A (2020). "A Methodology for Efficiency Recovering in Wireless Power Transfer Applications with Misalignment" 2020 33rd General Assembly and Scientific Symposium of the International Union of Radio Science, URSI GASS 2020. ISSN: [DOI] [URL]

[19] Fontana N, Giampietri E, Canicatti E, Brizi D and Monorchio A (2020). "Broadband Numerical Evaluation of SAR Distribution Due to High-Intensity Radiated Fields by Portable Systems" 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 - Proceedings. , 307-308. ISSN: [DOI] [URL]

[20] Gelli S and Martorella M (2020). "A cognitive architecture for space time adaptive processing" 2020 IEEE International Radar Conference, RADAR 2020. , 117-122. ISSN: [DOI] [URL]

[21] Gentile L, Capria A, Saverino A, Hajdaraj Z and Martorella M (2020). "DVB-S2 passive bistatic radar for resident space object detection: Preliminary results" 2020 IEEE International Radar Conference, RADAR 2020. , 607-611. ISSN: [DOI] [URL]

[22] Ghio S and Martorella M (2020). "A comparison of radon domain approaches for resident space object's parameter estimation" Proceedings International Radar Symposium. 2020-October, 318-322. ISSN: [DOI] [URL]

2020

[23] *Giampietri E, Brizi D, Monorchio A and Fontana N (2020). "Miniaturized Antennas Design for Microwave Imaging Applications" 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 - Proceedings. , 537-538. ISSN: [DOI] [URL]*

[24] *Giusti E, Saverino A, Martorella M and Berizzi F (2020). "A Rule-Based Cognitive Radar Design for Target Detection and Imaging" IEEE Aerospace and Electronic Systems Magazine. 35(6), 34-44. ISSN: [DOI] [URL]*

[25] *Kang H, Li J, Guo Q and Martorella M (2020). "Pattern Coupled Sparse Bayesian Learning Based on UTAMP for Robust High Resolution ISAR Imaging" IEEE Sensors Journal. 20(22), 13734-13742. ISSN: [DOI] [URL]*

[26] *Lupidi A, Greiff C, Bruggenwirth S, Brandfass M and Martorella M (2020). "Polarimetric radar technology for european defence superiority - The polrad project" Proceedings International Radar Symposium. 2020-October, 6-10. ISSN: [DOI] [URL]*

[27] *Martorella M and Aboutanios E (2020). "BalSAR: A Stratospheric Balloon-Borne SAR System" NATO Science for Peace and Security Series B: Physics and Biophysics. , 283-294. ISSN: [DOI] [URL]*

[28] *Mishra V, Costa F and Monorchio A (2020). "Study of Surface Wave and Transmission Properties in Radome Surface" 2020 33rd General Assembly and Scientific Symposium of the International Union of Radio Science, URSI GASS 2020. ISSN: [DOI] [URL]*

[29] *Mishra V, Costa F and Monorchio A (2020). "Analysis of Electromagnetic Band Gap and Absorption Properties of High-Impedance Structures" 2020 IEEE International Symposium on Antennas and Propagation and North American Radio Science Meeting, IEEECONF 2020 - Proceedings. , 903-904. ISSN: [DOI] [URL]*

[30] *Oveis A, Martorella M, Sebt M and Noroozi A (2020). "A Computationally Efficient Approach for Velocity Estimation of Ground Moving Targets" IEEE National Radar Conference - Proceedings. 2020-September ISSN: [DOI] [URL]*

[31] *Serafino G, Bernabo P, Cuccoli F and Lupidi A (2020). "Emission pollution reduction by EFB implemented trajectory optimizer" 2020 IEEE International Workshop on Metrology for AeroSpace, MetroAeroSpace 2020 - Proceedings. , 49-53. ISSN: [DOI] [URL]*

[32] *Tomei S, Gentile L, Giusti E, Martorella M, Strappavecchia S, Vigilante D, Timmoneri L and Farina A (2020). "Progress on the Study for the Use of Long-Range Radars for Space Situational Awareness" IEEE National Radar Conference - Proceedings. 2020-September ISSN: [DOI] [URL]*

[33] *Tomei S, Lupidi A, Stagliano D, Lischi S, Petri D, Massini R and Martorella M (2020). "NORMA - A noise radar network for covert border surveillance" Proceedings International Radar Symposium. 2020-October, 197-201. ISSN: [DOI] [URL]*

[34] *Usai P, Costa F and Monorchio A (2020). "On the use of engineered artificial materials for realistic stealth applications" 2020 International Workshop on Antenna Technology, iWAT 2020. ISSN: [DOI] [URL]*

From January 2017 the RaSS Lab has been certified ISO 9001/2015 by the international and independent body DNV GL. The certification refers to the "Design and development of technology systems and services in telecommunications, radar and electromagnetism and related computer aids and the design and manufacture of RF and microwave equipment and subsystems" (Figure 4).

DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No: 211274-2016-AQ-ITA-ACCREDIA

Initial certification date: 19 January 2017

Valid: 20 January 2020 - 19 January 2023

This is to certify that the management system of

Consorzio Nazionale Interuniversitario per le Telecomunicazioni - Laboratorio Nazionale RaSS - Radar e Sistemi di Sorveglianza

Galleria G.B. Gerace, 18 - 56024 Pisa (PI) - Italy

has been found to conform to the Quality Management System standard:

ISO 9001:2015

This certificate is valid for the following scope:

Design and development of technology systems and services in telecommunications, radar and electromagnetics and related computer aids. Design and manufacturing of radiofrequency and microwaves equipments and subsystems (IAF 34, 19, 33)

Place and date:
Vimercate (MB), 07 January 2020

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

SGQ N° 003 A
SGA N° 003 D
SGE N° 007 M
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EMAS N° 009 P
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Membro di MLA EA per gli schemi di accreditamento SGQ, SGA, PRD, PRS, ISP, GHG, LAB e LAT, di MLA IAF per gli schemi di accreditamento SGQ, SGA, SSI, FSM e PRD e di MRA ILAC per gli schemi di accreditamento LAB, MED, LAT e ISP

For the issuing office:
DNV GL - Business Assurance
Via Energy Park, 14, - 20871 Vimercate (MB) - Italy

Zeno Beltrami
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL Business Assurance Italia S.r.l., Via Energy Park, 14 - 20871 Vimercate (MB) - Italy. TEL:+39 68 99 905. www.dnvgl.it

Figure 4 - Lab RaSS ISO 9001/2015 DNV certificate.

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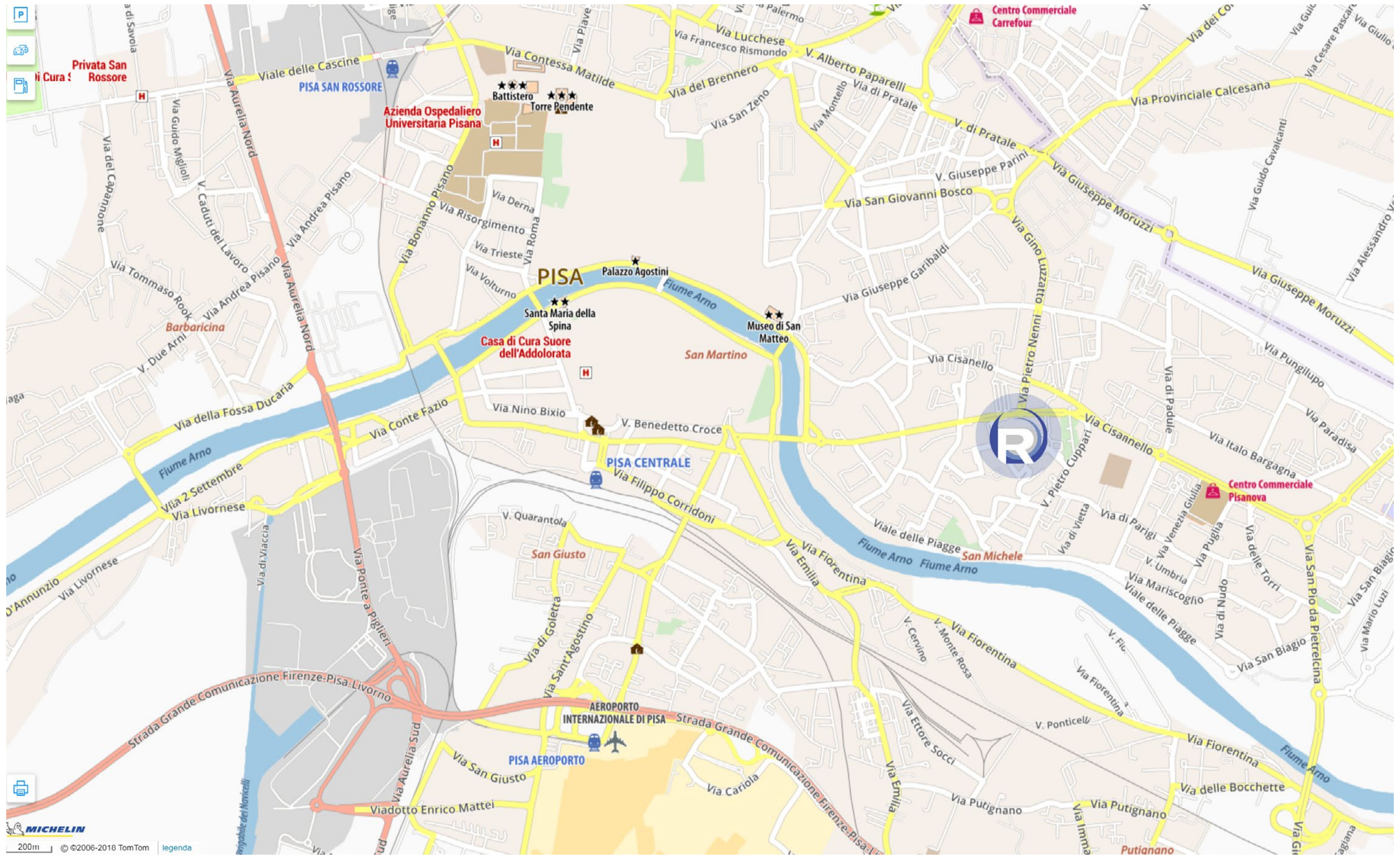

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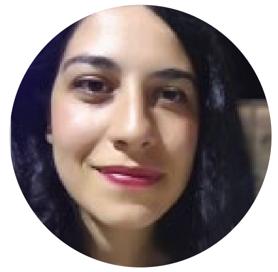

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