

# 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 waveforms, which enable Low Probability of Intercept (LPI) characteristic and, hence, covert surveillance operational mode
- radar imaging capability with noise waveforms, 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

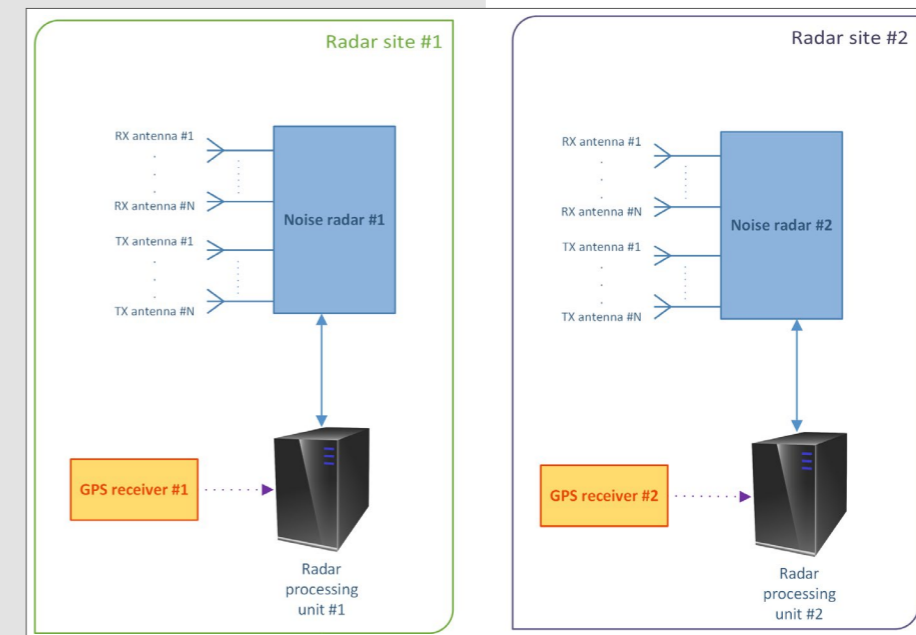
IRE NASU with the participation of Echoes s.r.l

### Project duration

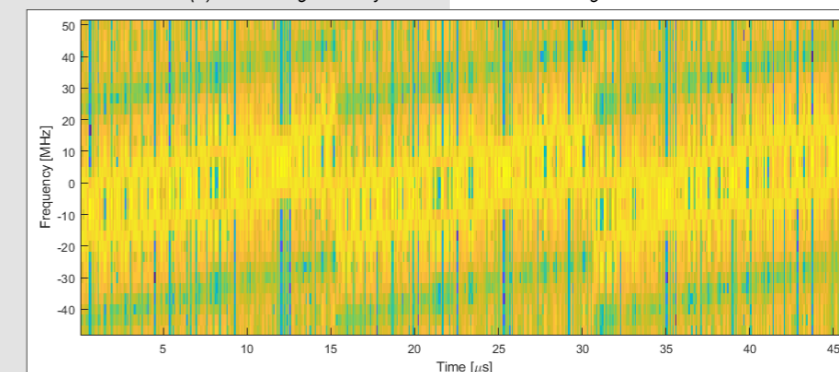
May 2018 – May 2021

### Involved countries

Italy, Ukraine

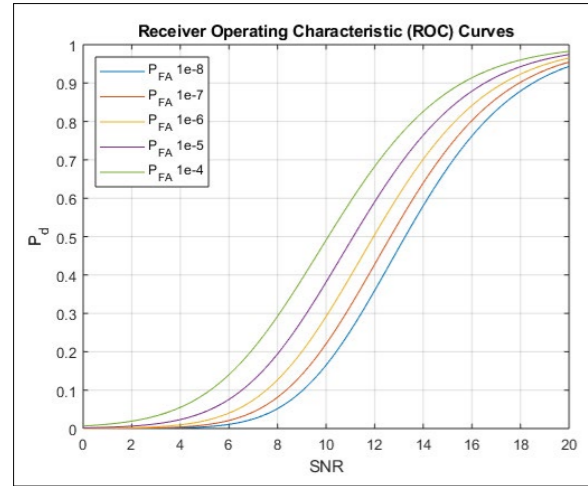


(a) NORMA high level system architecture including two noise r

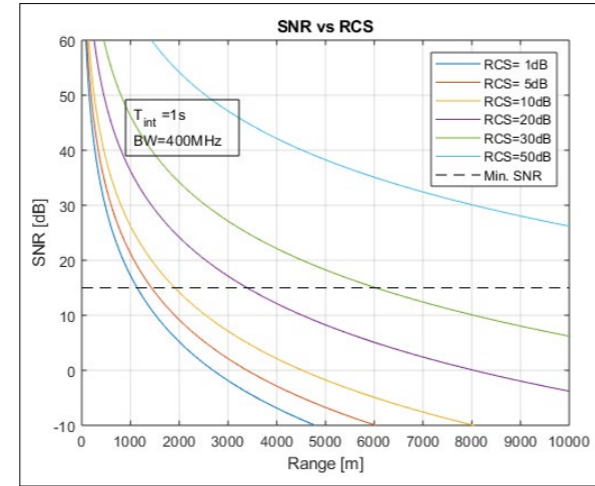


(b) PRBS (pseudorandom binary sequences) modulated FMCW waveform, 30MHz noise bandwidth. The typical "ramp" of FMCW signal is completely masked by the noise, leading to pseudo random noise like waveforms and, hence, LPI operations © [2020] IEEE. Reprinted, with permission, from [S. Tomei et al., "NORMA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

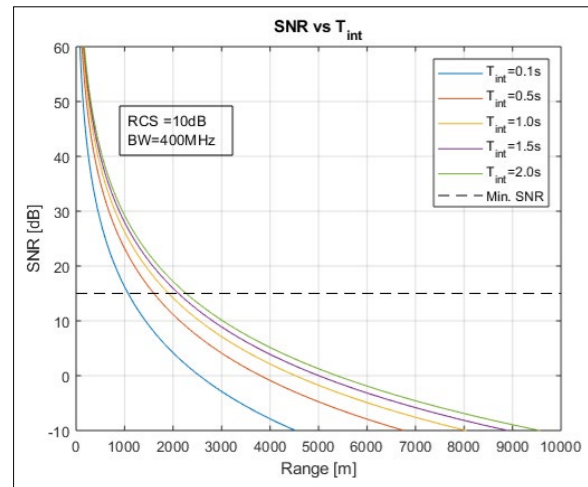




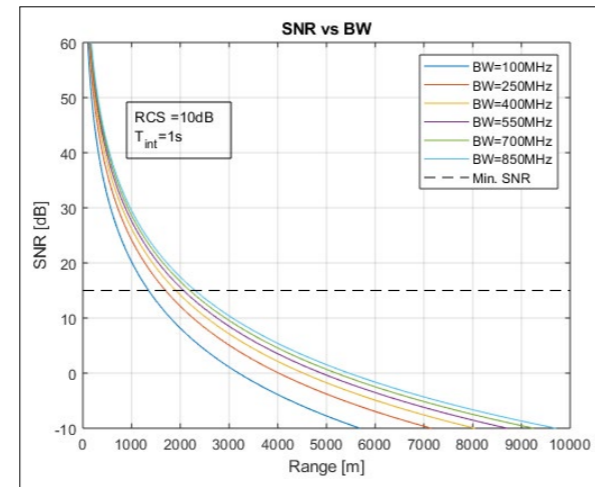
(c) ROC curves for Swerling III model



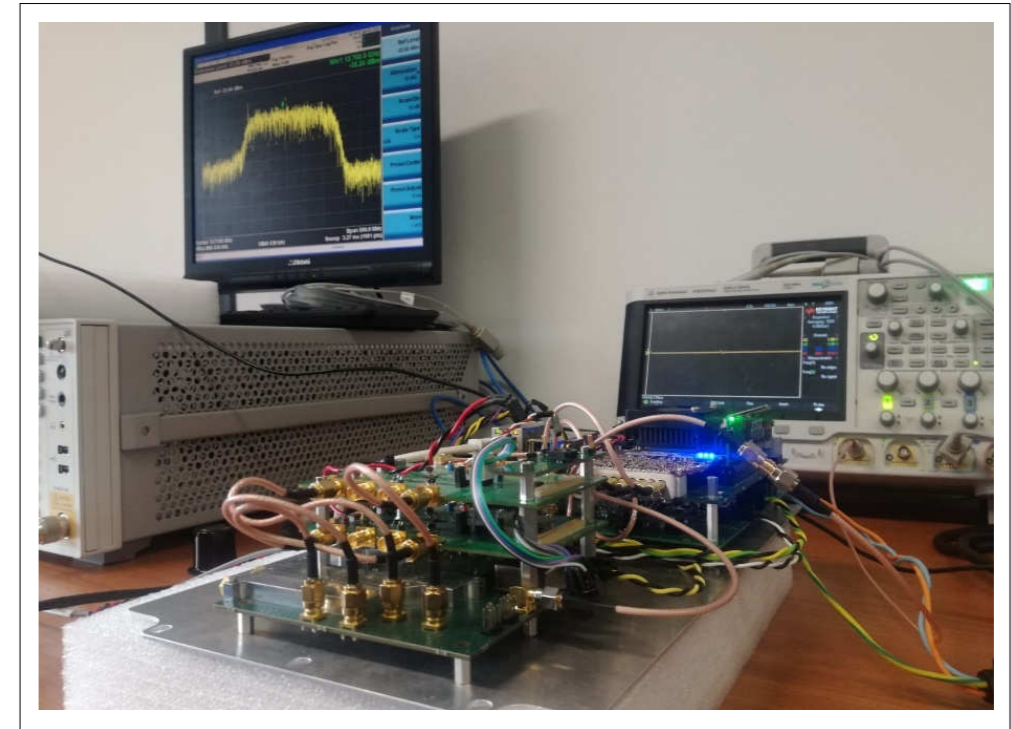
(d) SNR with respect to range distance with the varying of the target RCS



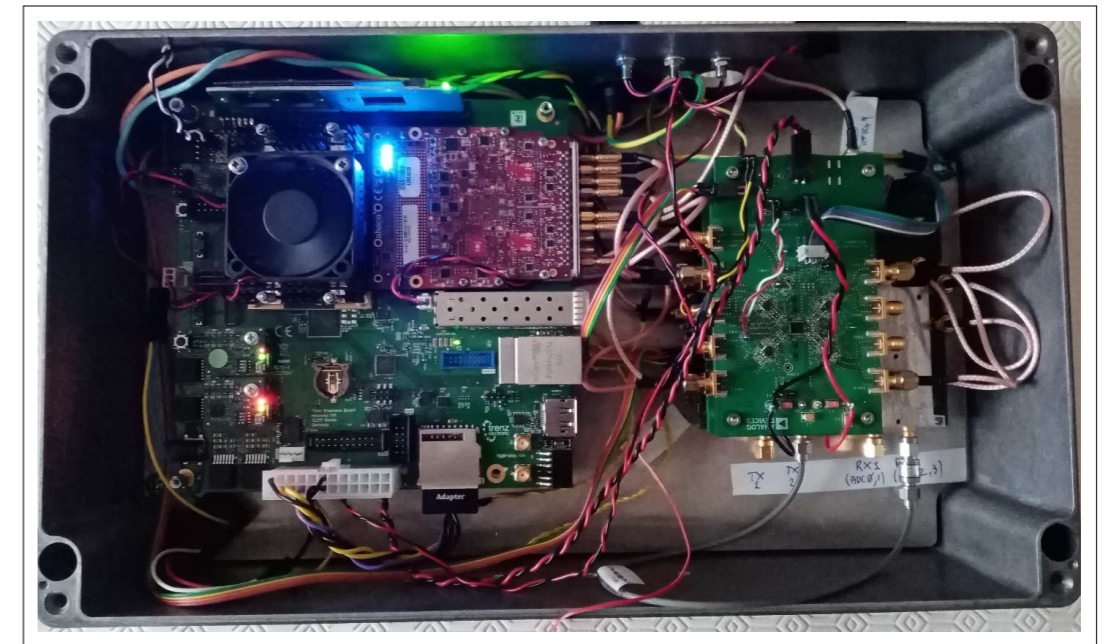
(e) SNR with respect to range distance with the varying of the coherent processing interval



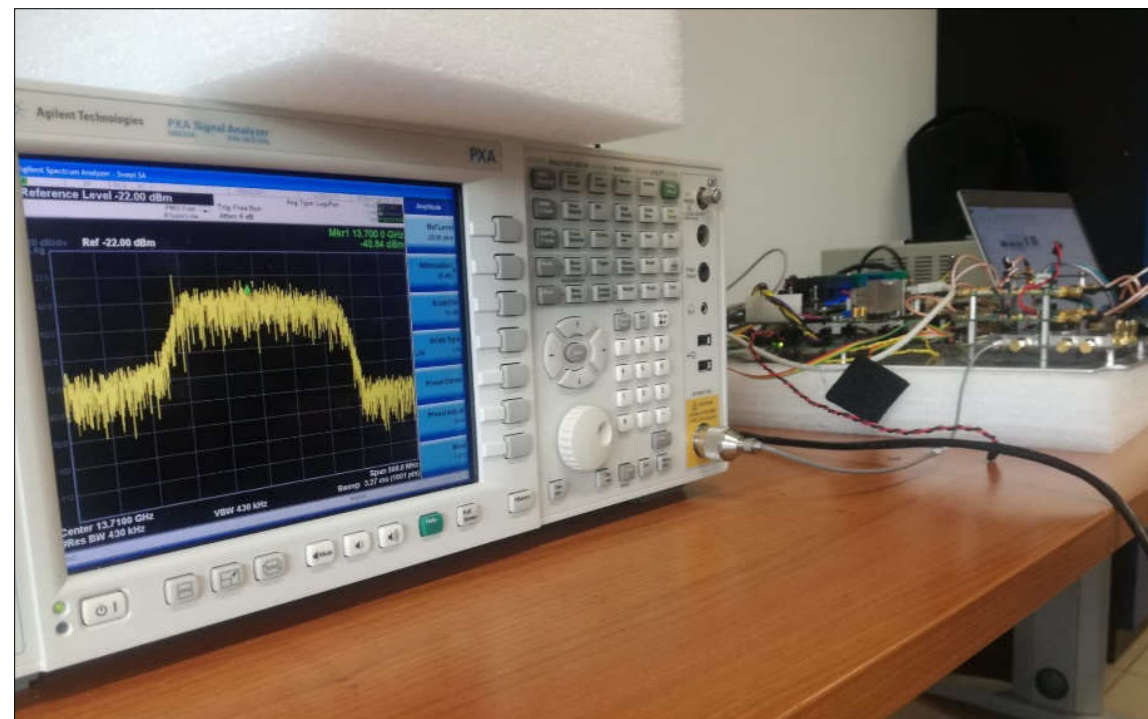
(f) SNR with respect to range distance with the varying of the transmitted waveform bandwidth



(h) Measurement testbench Oscilloscope and radar out of the box



(i) Radar Box for loopback test



(g) Measurement testbench: spectrum analyser