

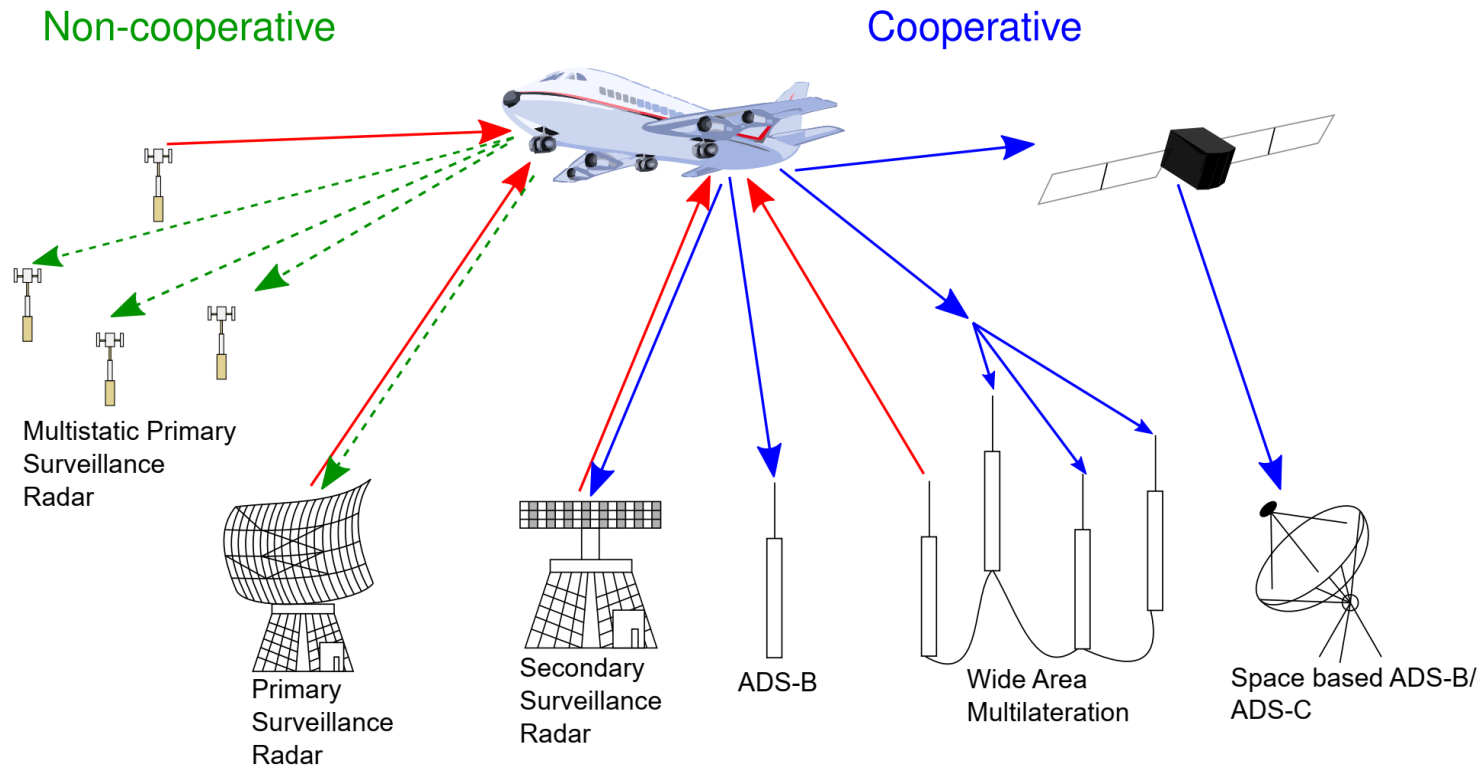
ASTONISH

Scenarios and system configuration analyses of LDACS- SUR and DARN for validation campaign in the ASTONISH project

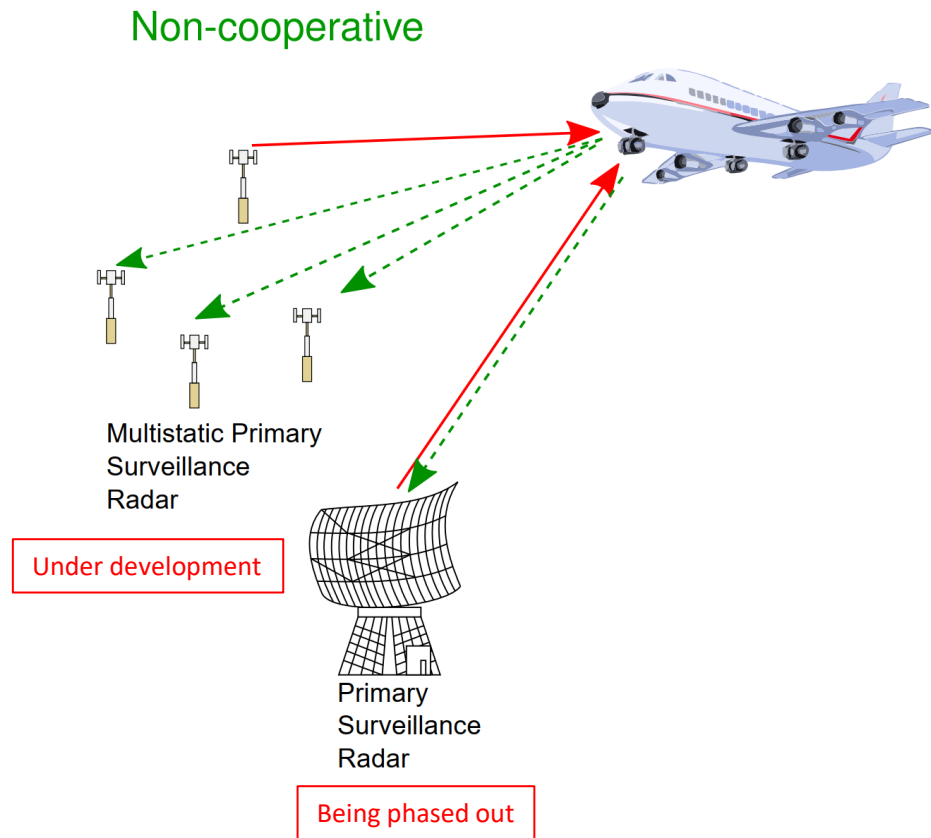
Alberto Arana Ragel

SESAR Innovation Days 2025, Bled, 4th December 2025

ASTONISH Motivation (1/2)



ASTONISH Motivation (2/2)

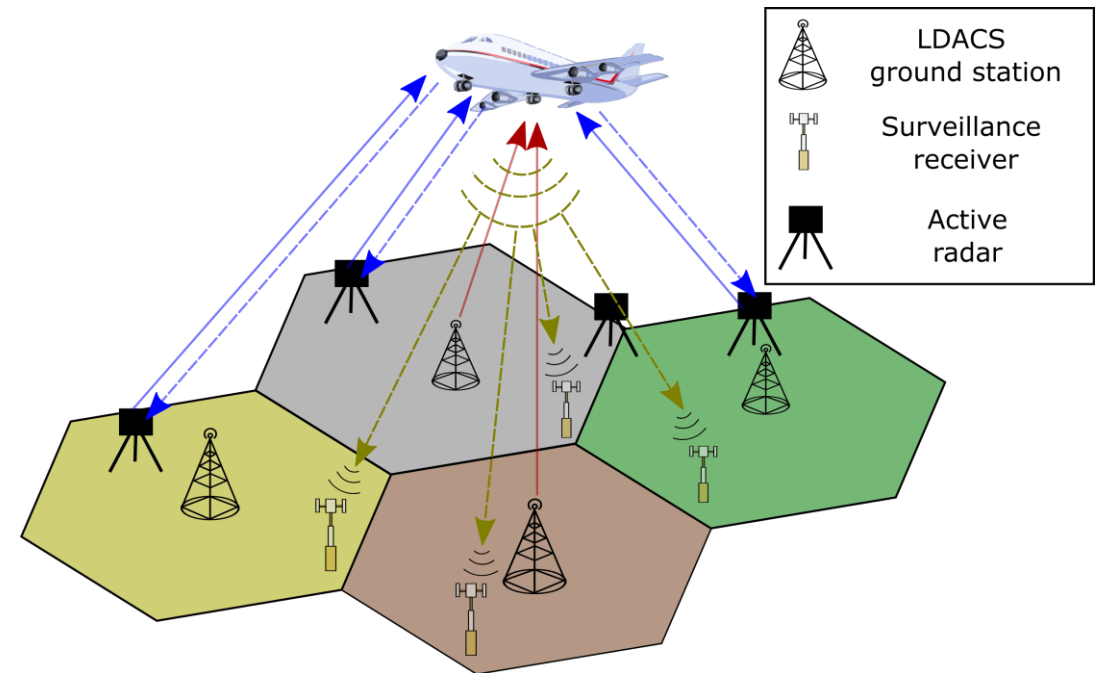


ASTONISH Our Solution

New ground-based non-cooperative alternative surveillance solutions to improve the resilience of the surveillance services:

- Multistatic passive radar LDACS-SUR
- Distributed active radar network (DARN)

Objective: TRL2 by the end of the project



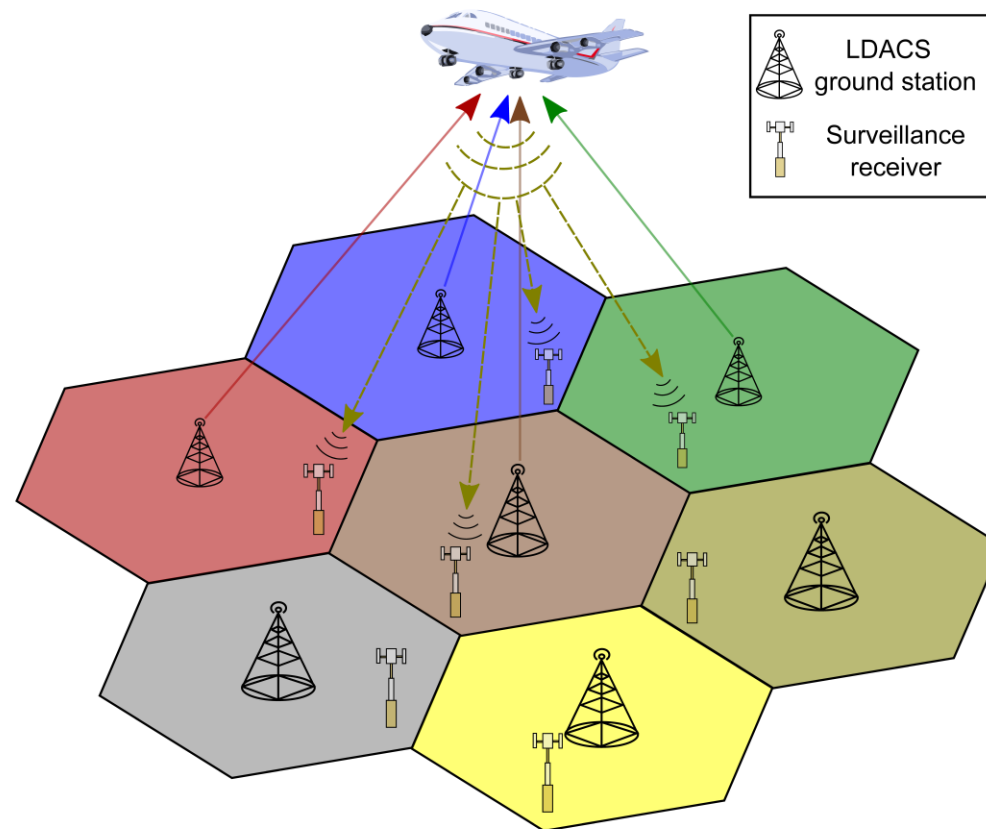
ASTONISH LDACS-SUR – System Overview

LDACS (L-Band Digital Aeronautical Communication System):

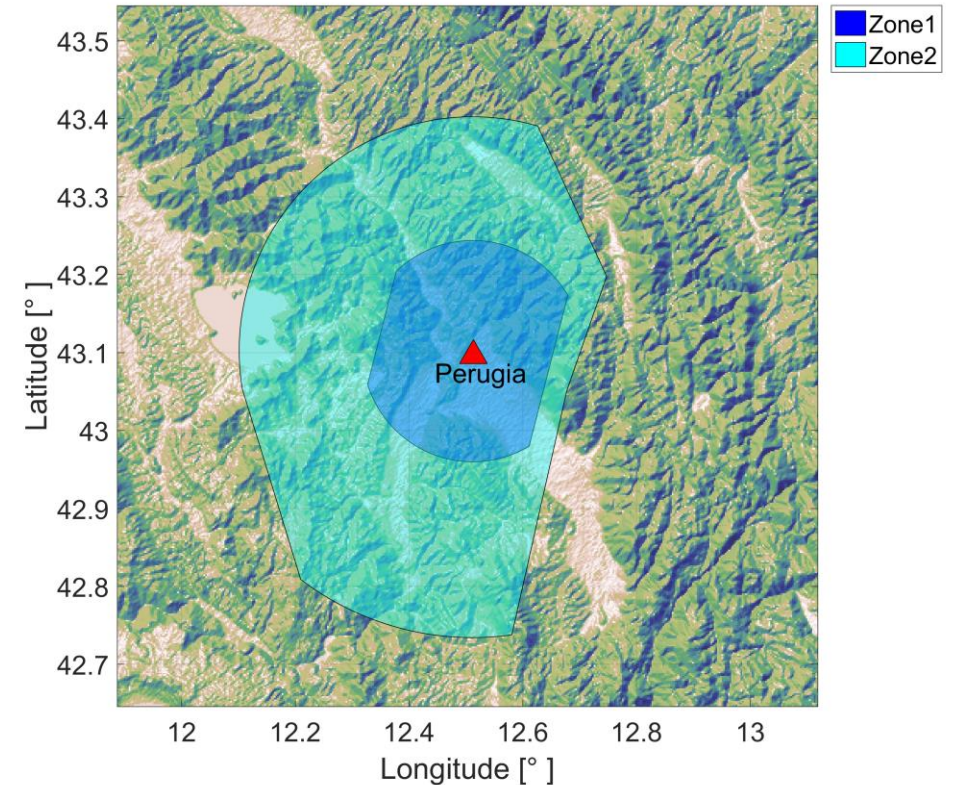
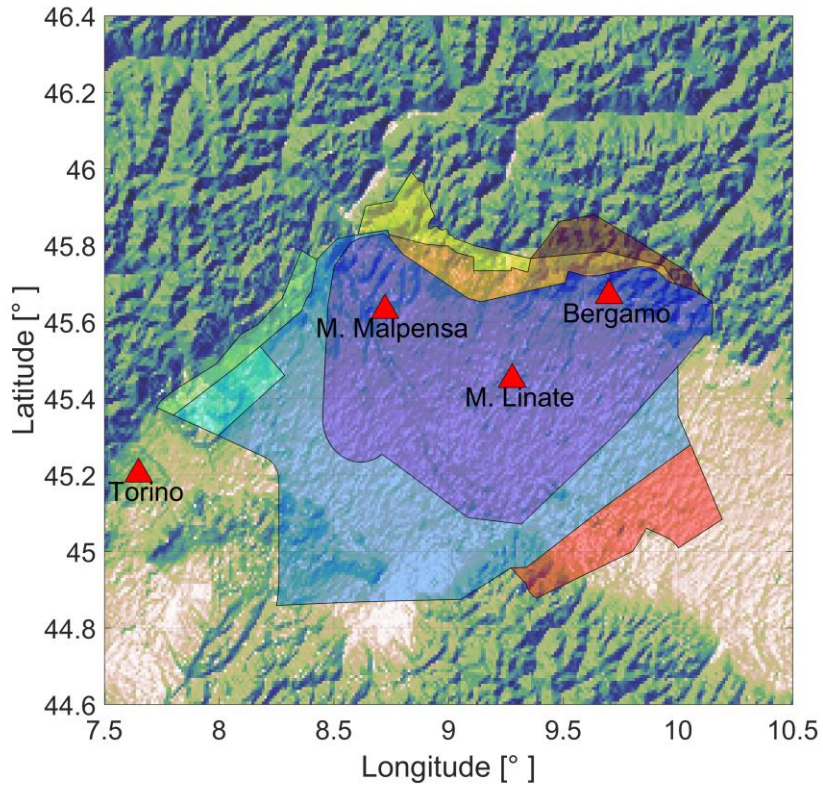
- Future air-to-ground aeronautical communication link
- Undergoing the ICAO standardization
- Foresees COM, NAV and SUR functionalities

LDACS-SUR

- Employs LDACS communication signals as signals of opportunity
- Non-cooperative passive multistatic radar system



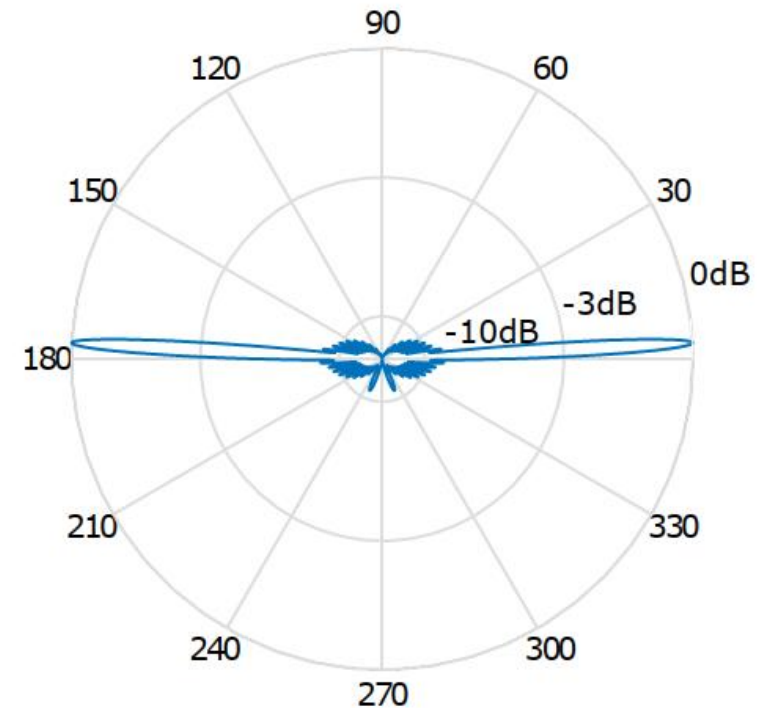
ASTONISH LDACS-SUR – Validation Scenarios



ASTONISH LDACS-SUR – Tx Configuration

Transmitting antenna of the ground station modeled after commercially available L-band antennas:

- Stack of vertically polarized dipoles
- Omni-directional pattern in azimuth
- 12 dBi of maximum antenna gain
- Transmit power defined by compatibility study



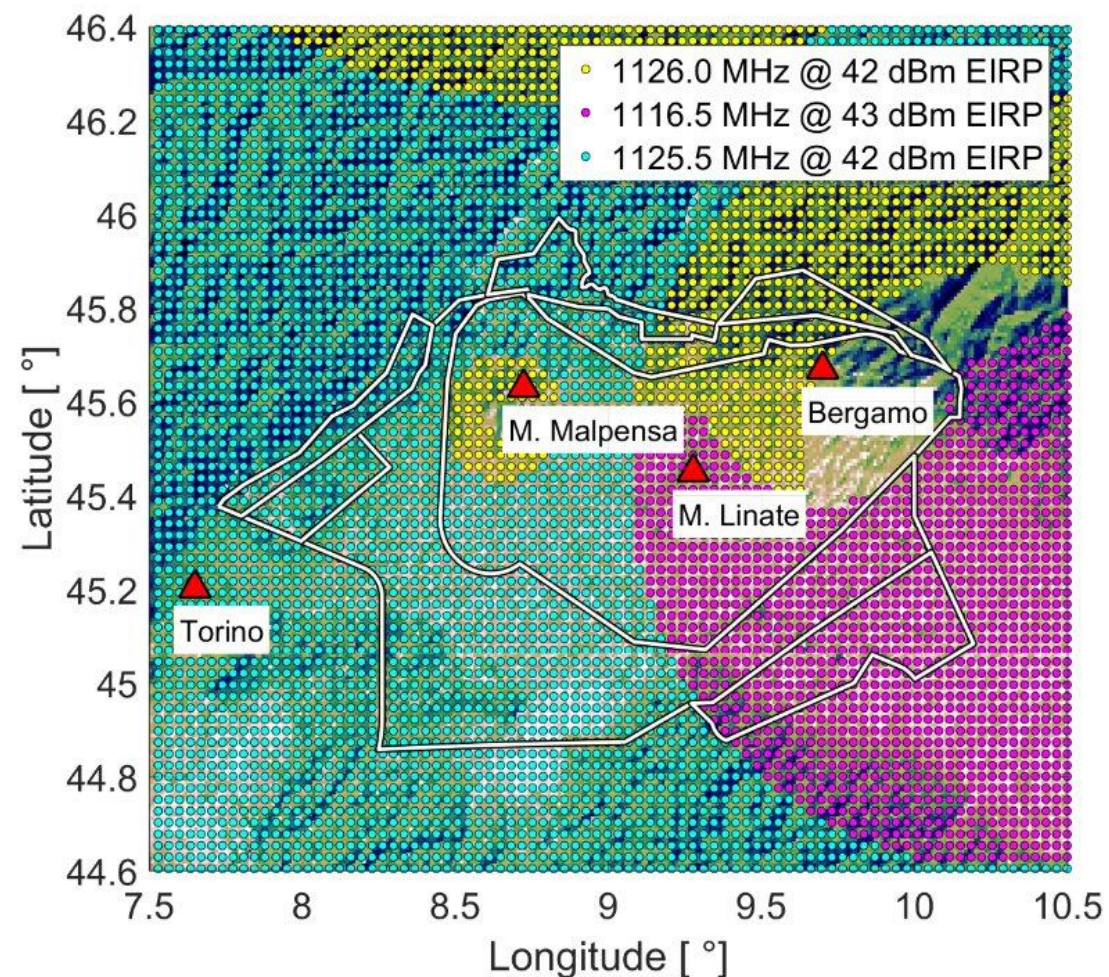
ASTONISH LDACS-SUR – Tx Positioning

Tx positions selected in accordance with LDACS-COM requirements. A compatibility study identified valid locations without disturbing:

- Any aeronautical radionavigation service (ARNS) in accordance with ITU Resolution 417
- Distance Measuring Equipment/TACTical Air Navigation system (DME/TACAN).

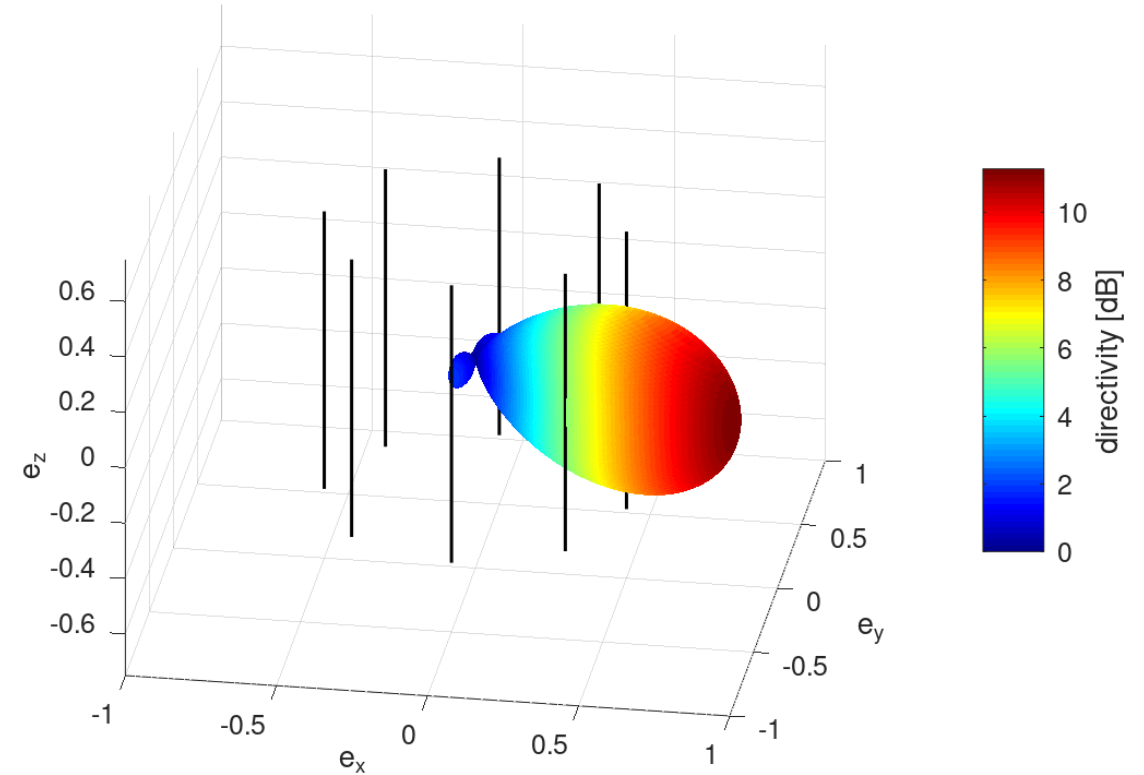
Result:

- No issues in Perugia CTR
- 3 out of 4 considered locations compatible in Milan TMA



ASTONISH LDACS-SUR – Rx Configuration

Rx parameter	Value
Bandwidth	498050 Hz
Number of elements	8
Element distribution	Uniform
Array shape	Circular
Single beam gain	11.9 dBi
Azimuth coverage	360°
Noise figure	6 dB
Rx losses	3 dB



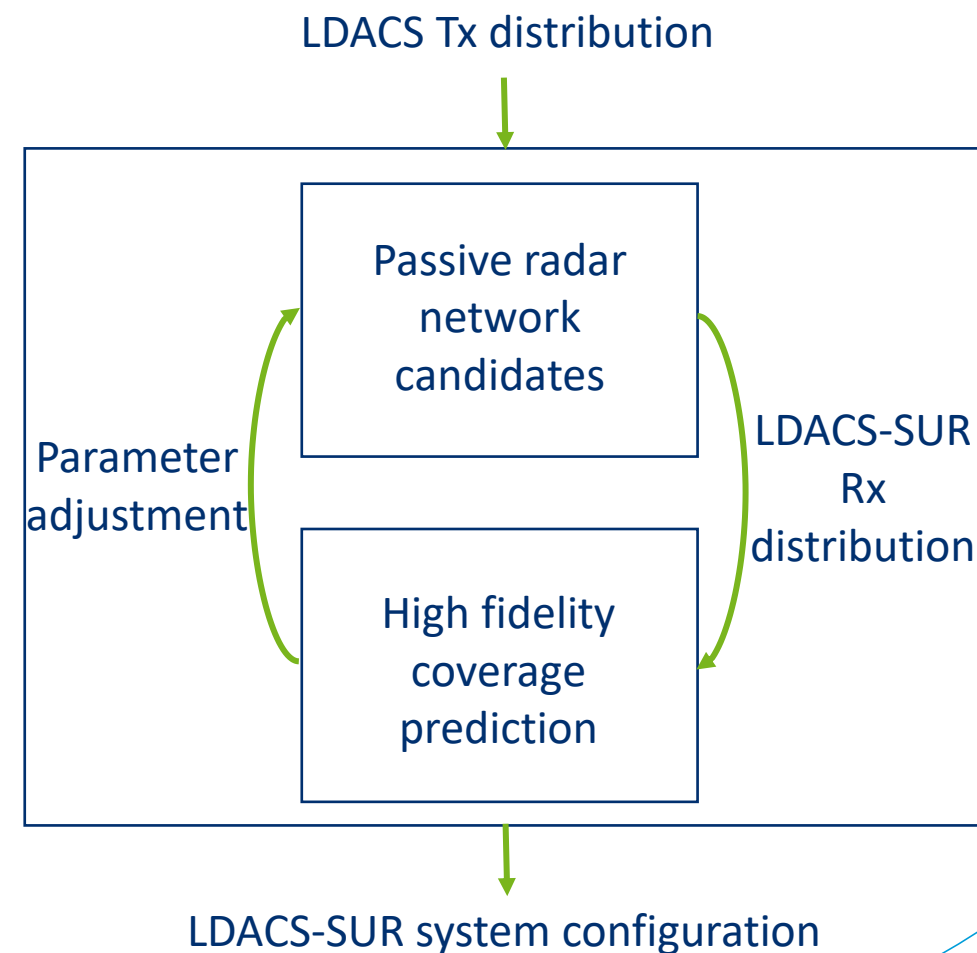
ASTONISH LDACS-SUR – Rx Positioning Strategy

Conditions considered to define Rx position candidates:

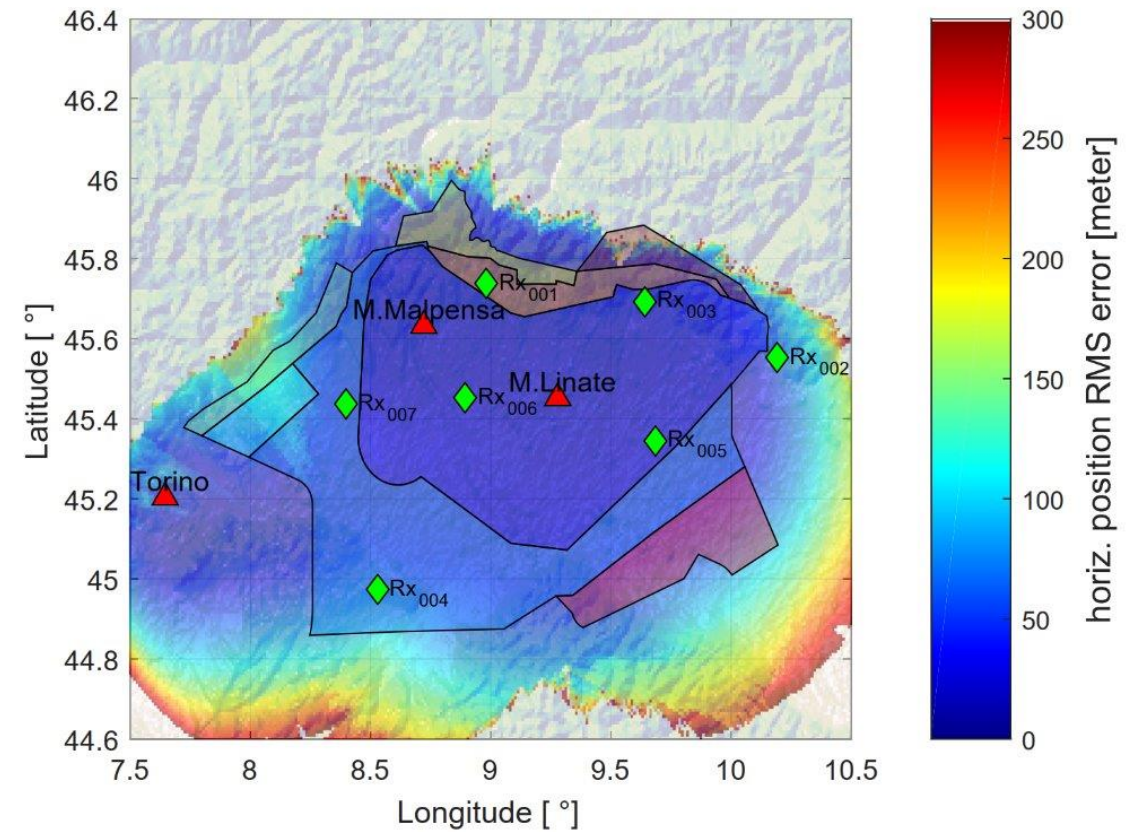
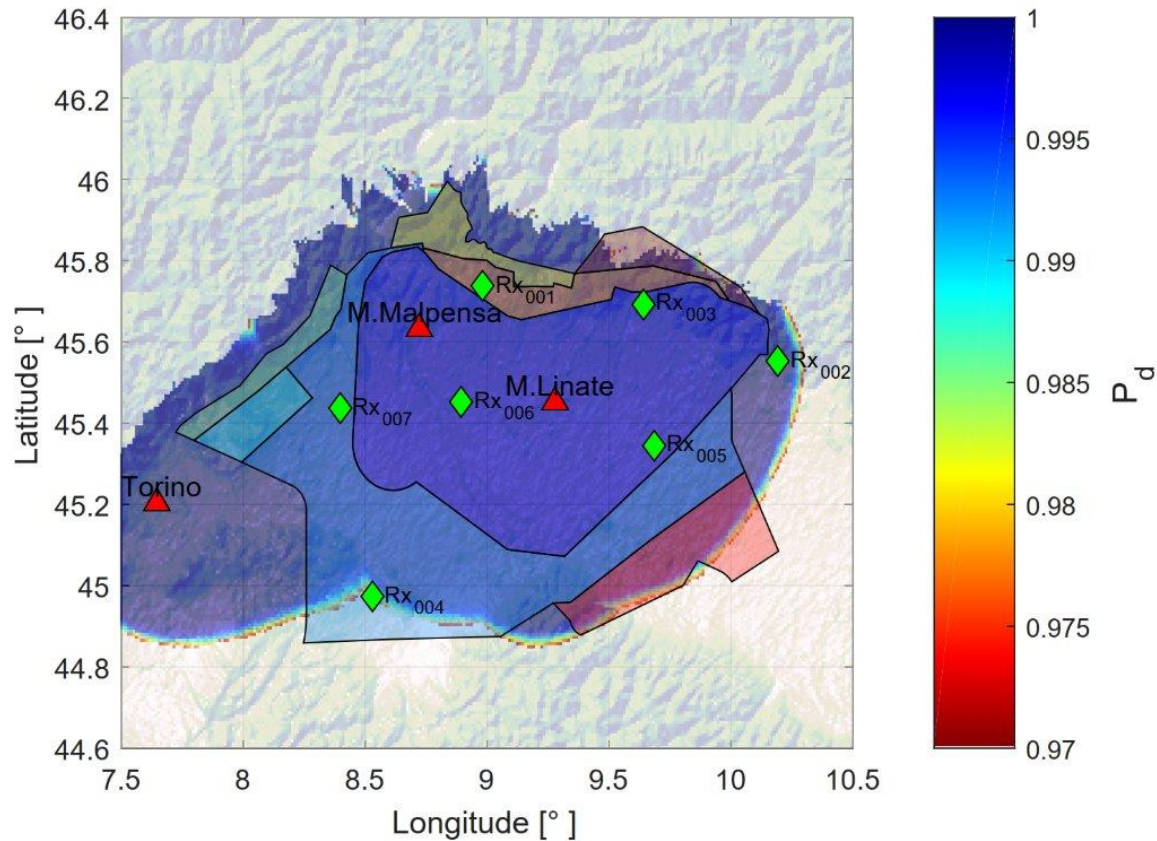
- Signal propagation based on the specific orography
- Bistatic probability of detection performance
- Reference channel received power
- Direct signal interference

The radar network is then optimized based on:

- Achievable position estimation error based on the Cramer-Rao Bound
- Limited number of distributed Rx
- Aggregated multistatic probability of detection

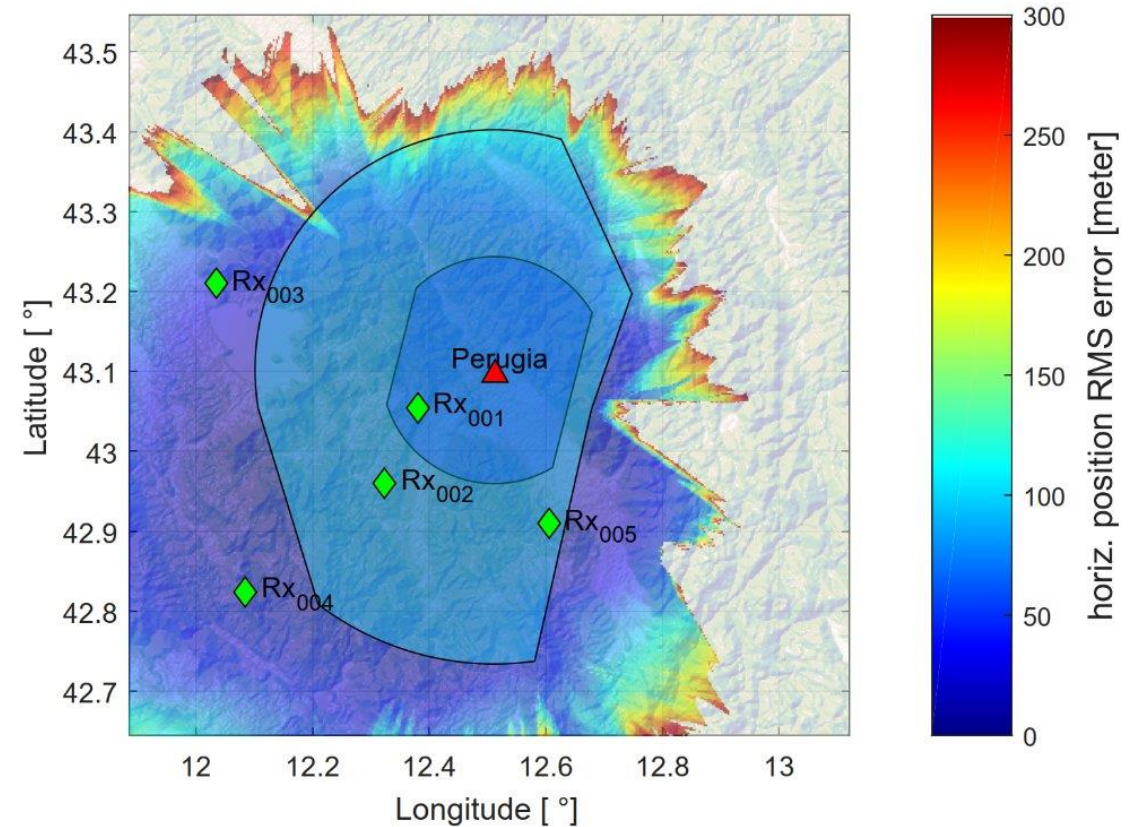
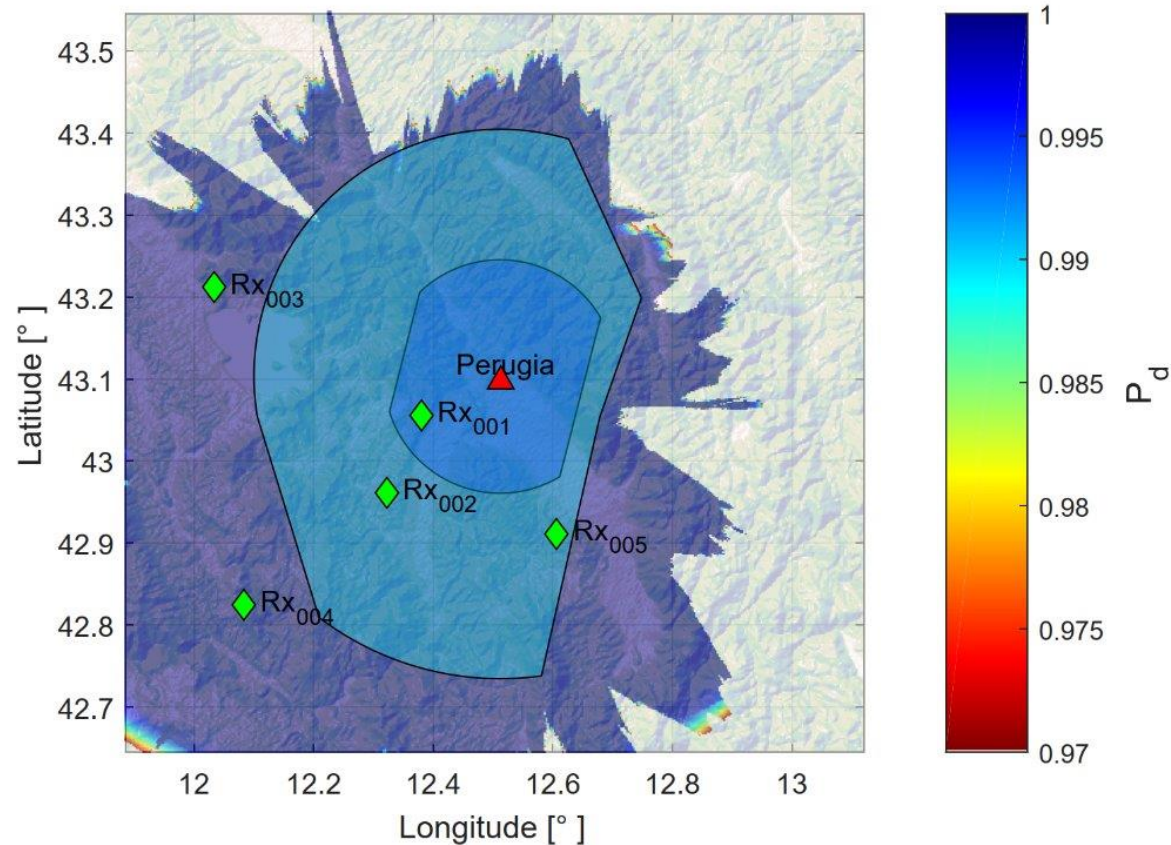


ASTONISH LDACS-SUR – Milan Deployment



Coverage results for LDACS-SUR Rx configuration at 4500ft AMSL

ASTONISH LDACS-SUR – Perugia Deployment



Coverage results for LDACS-SUR Rx configuration at 4500ft AMSL

ASTONISH LDACS-SUR – Conclusion and Future Work

- Milan TMA:
 - Need for distributed network of LDACS-Tx
 - Rx capable of processing multiple LDACS-bands simultaneously
 - Full coverage could be achieved with Rx gap-fillers.
 - The Rx performance could be improved with direction finding capabilities at the Rx level
- Perugia CTR:
 - Relevant requirement thresholds can be met for airspaces comparable in size to the Perugia CTR
- Given the defined system configurations, a simulation study based on true trajectories will be performed

ASTONISH DARN – System Overview

Netted radar systems can provide higher target detection and tracking capabilities, more accurate measurements, better multi-target tracking performance, and redundancy

We investigate a distributed active radar network of

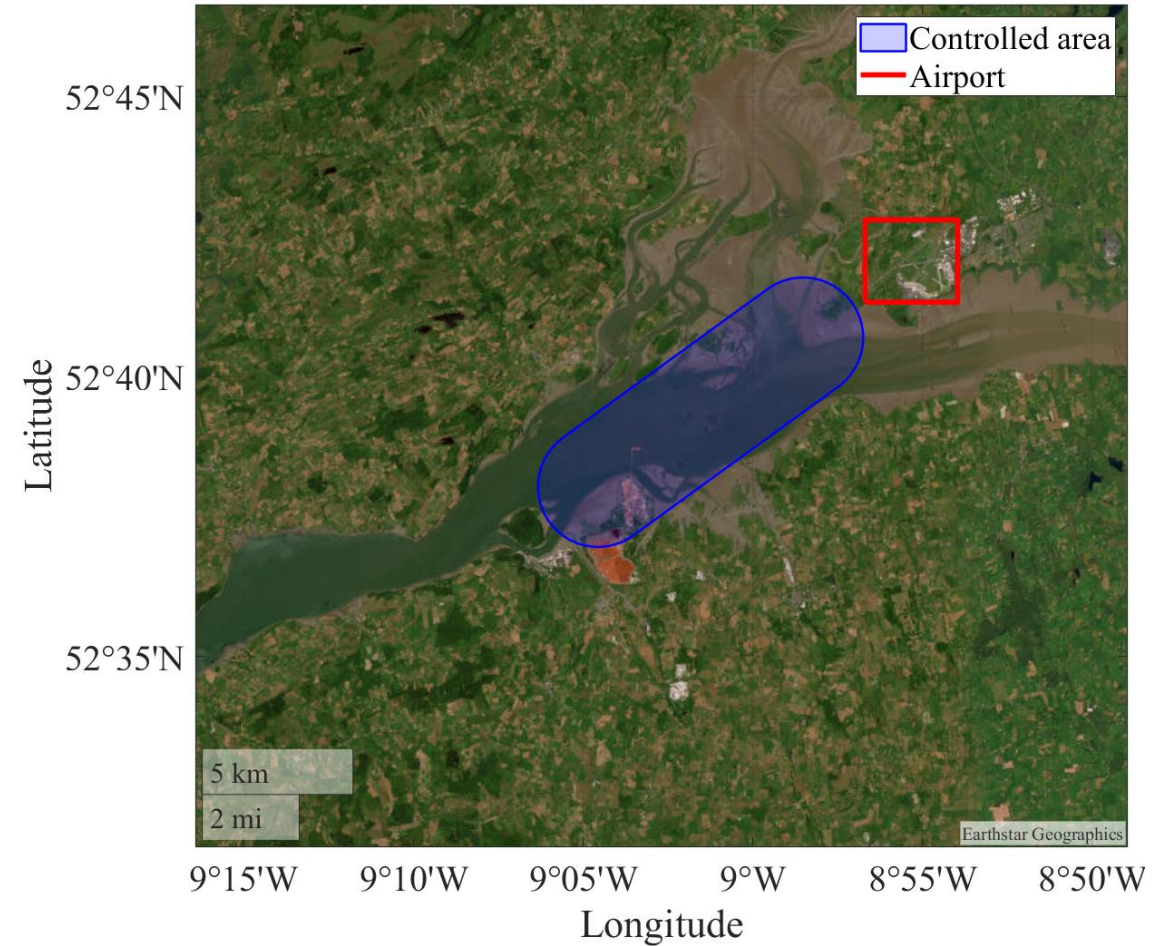
- Phased-array radars
- Monostatic

Parameter	Variable	Value
Transmitted Power	P_T	25 W
Frequency	F	9.6 GHz
Beamwidth	Δ	$\sim 2^\circ \times 2^\circ$
Bandwidth	B	6 MHz
Wavelength	λ	3.22 cm
Antenna Gain	G	37 dB
Range Limits	R	[1 30] km
Range Resolution	ΔR	25 m
Pulse duration	τ	$6.7 \mu s$
Number of pulses	N	8

ASTONISH DARN – Validation Scenario

Shannon airport (Ireland) is the scenario chosen for the DARN validation:

- Extension of 30×20 km
- Altitude from 300 ft AMSL up to FL100



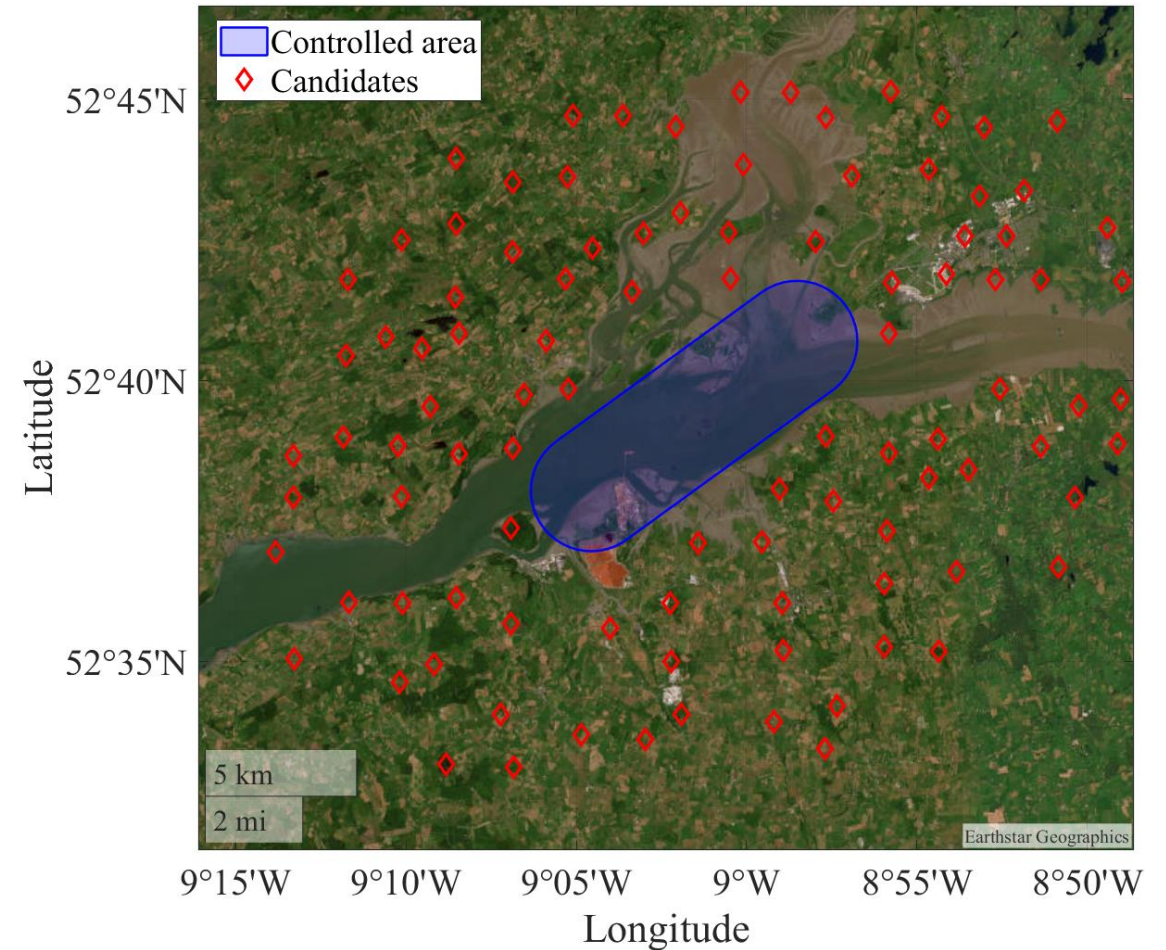
ASTONISH DARN – Radar Positioning Strategy

The procedure is divided in two main steps:

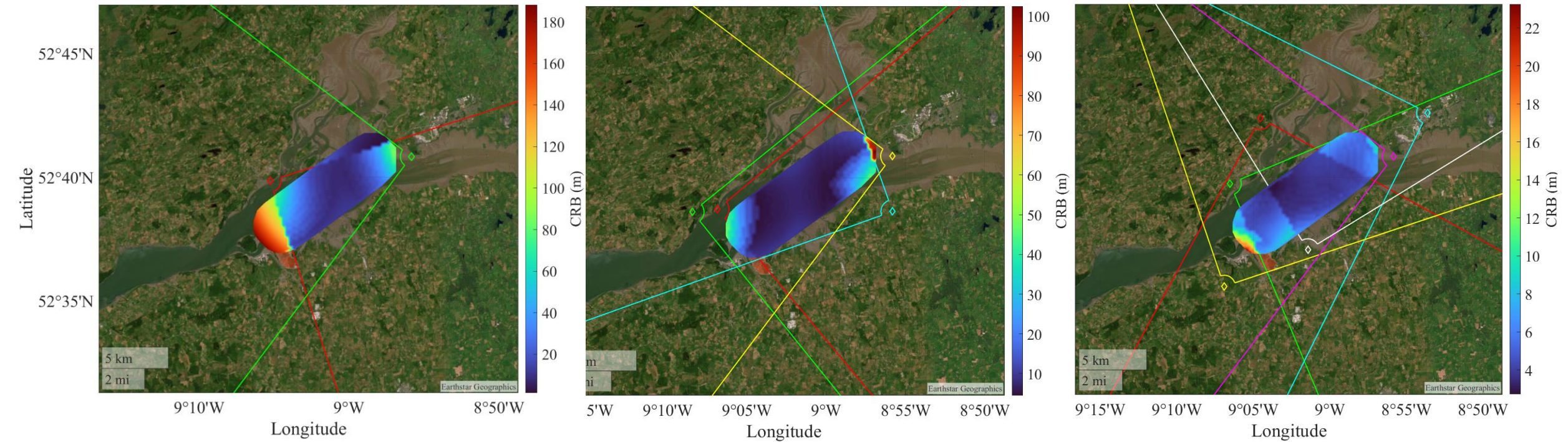
- 1) Extraction of candidate radar locations
- 2) Search for optimal positions

The positioning of the radars in the network is based on

- The Cramer-Rao Bound
- The joint probability of detection



ASTONISH DARN – Radar positioning



2 radars

4 radars

6 radars

ASTONISH DARN – Conclusion and Future Work

- In all the configurations showed, the network is able to cover the whole controlled area
- Simulations based on true trajectories and involving a central tracking system will be performed

ASTONISH

THANK YOU FOR
YOUR ATTENTION