The II National Workshop of SKA science and technology
Bologna, 3-5 December 2018

THE SKALA4-AL ANTENNA:
THE ITALIAN SOLUTION FOR SKA1-LOW

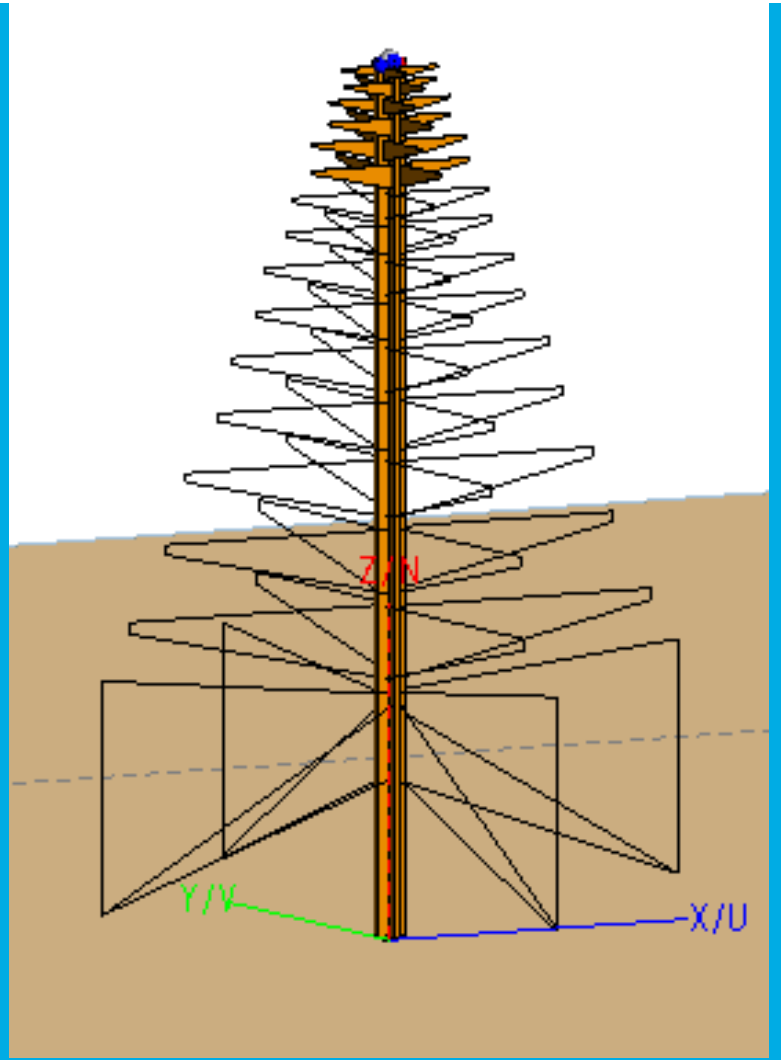
Pietro Bolli, Lorenzo Mezzadrelli, Jader Monari, Federico Perini,

Marco Schiaffino, Alberto Tibaldi, Giuseppe Virone

AGENDA

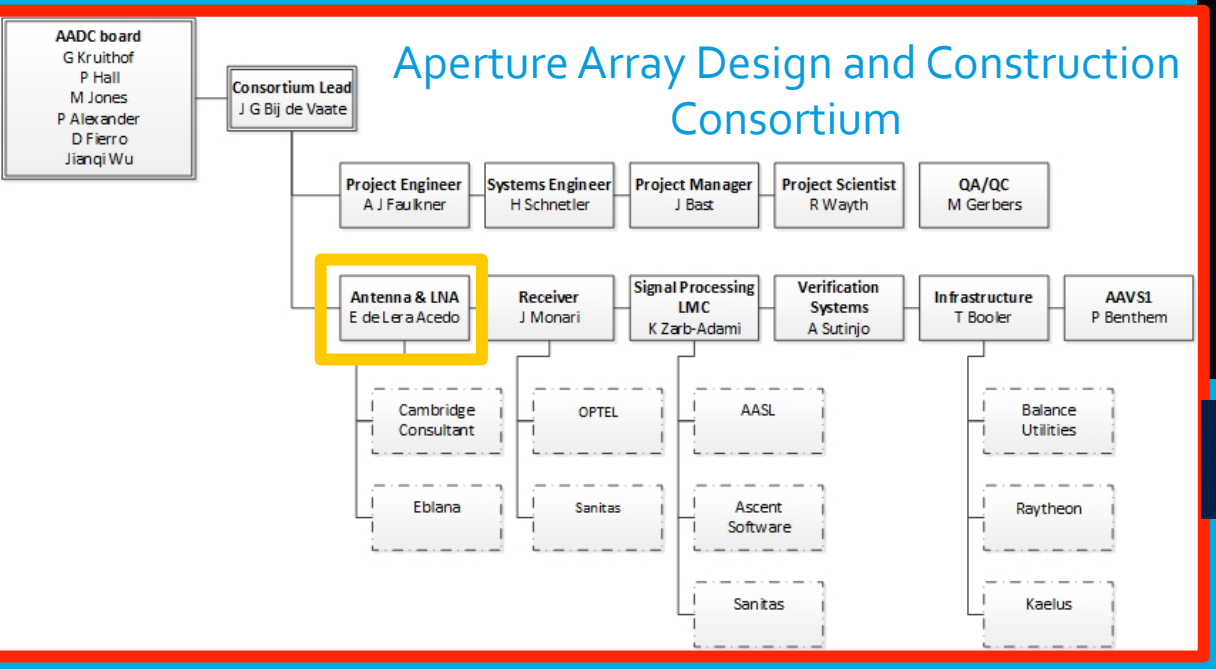
- Background
- From the conceptual design to a real antenna
- Main mechanical and electrical characteristics
- Low Noise Amplifier
- Numerical analysis and experimental tests
- Conclusions and next steps

SKALA4-AL



BACKGROUND

"To provide the design of a dual orthogonal polarization log-periodic antenna for SKA1-LOW able to measure EM radiation from 50 to 350 MHz, with a certain sensitivity at zenith and off-zenith beam response".



UNIVERSITY OF OXFORD

Science & Technology Facilities Council

ICRAR International Centre for Radio Astronomy Research

ASTRON

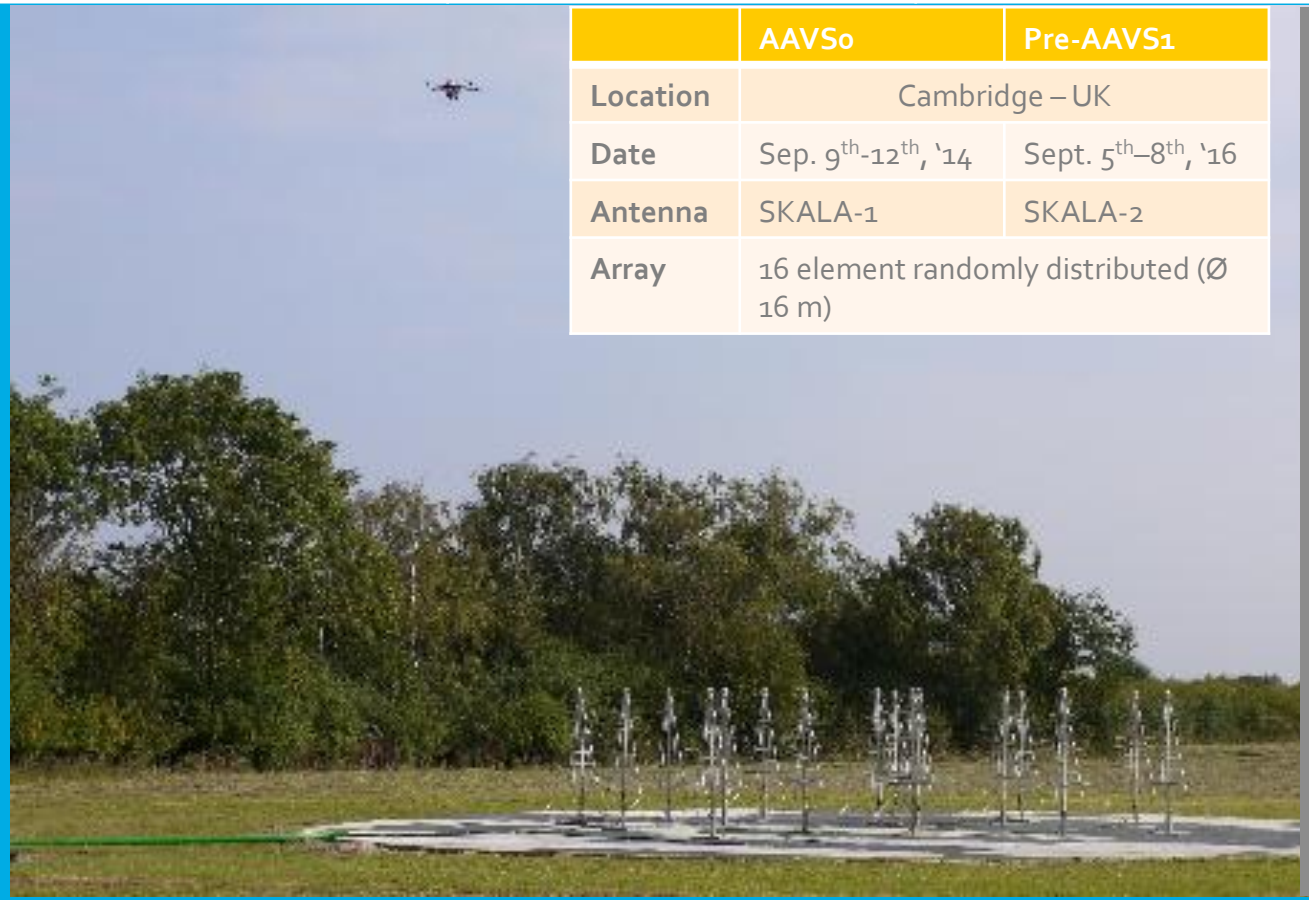
INAF ISTITUTO NAZIONALE DI ASTROFISICA NATIONAL INSTITUTE FOR ASTROPHYSICS

UNIVERSITY OF CAMBRIDGE

KLAASA Key Lab of Aperture Array and Space Application

FROM UAV TO ANTENNA DESIGN

2014	2015	2016	2017	2018

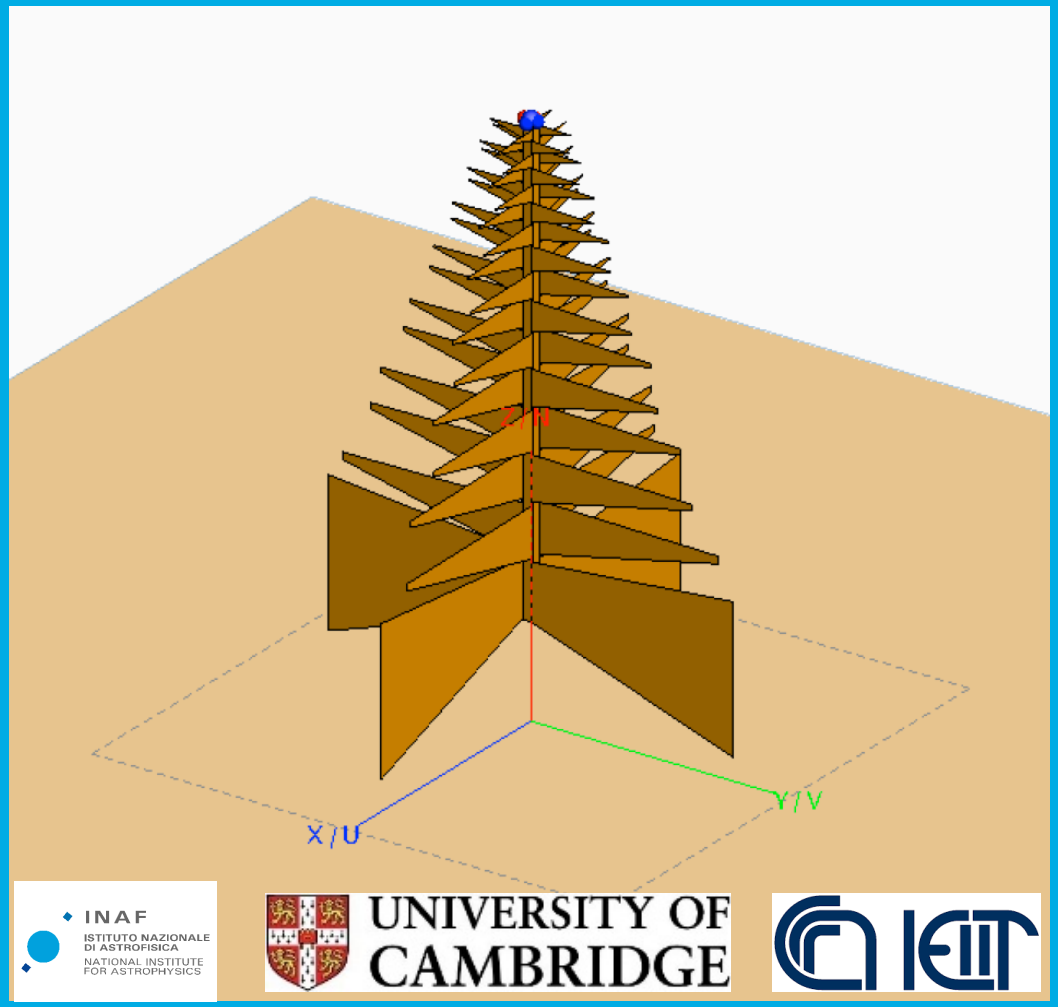


	AAVS0	Pre-AAVS1
Location	Cambridge – UK	
Date	Sep. 9th-12th, '14	Sept. 5th–8th, '16
Antenna	SKALA-1	SKALA-2
Array	16 element randomly distributed (Ø 16 m)	

Cost Control Project

WS2: Review alternative antenna designs

SKALA4: CONCEPTUAL EM DESIGN



SKALA4 is an optimization of the previous SKALA versions (SKALA, SKALA2 and SKALA3) developed at the University of Cambridge.

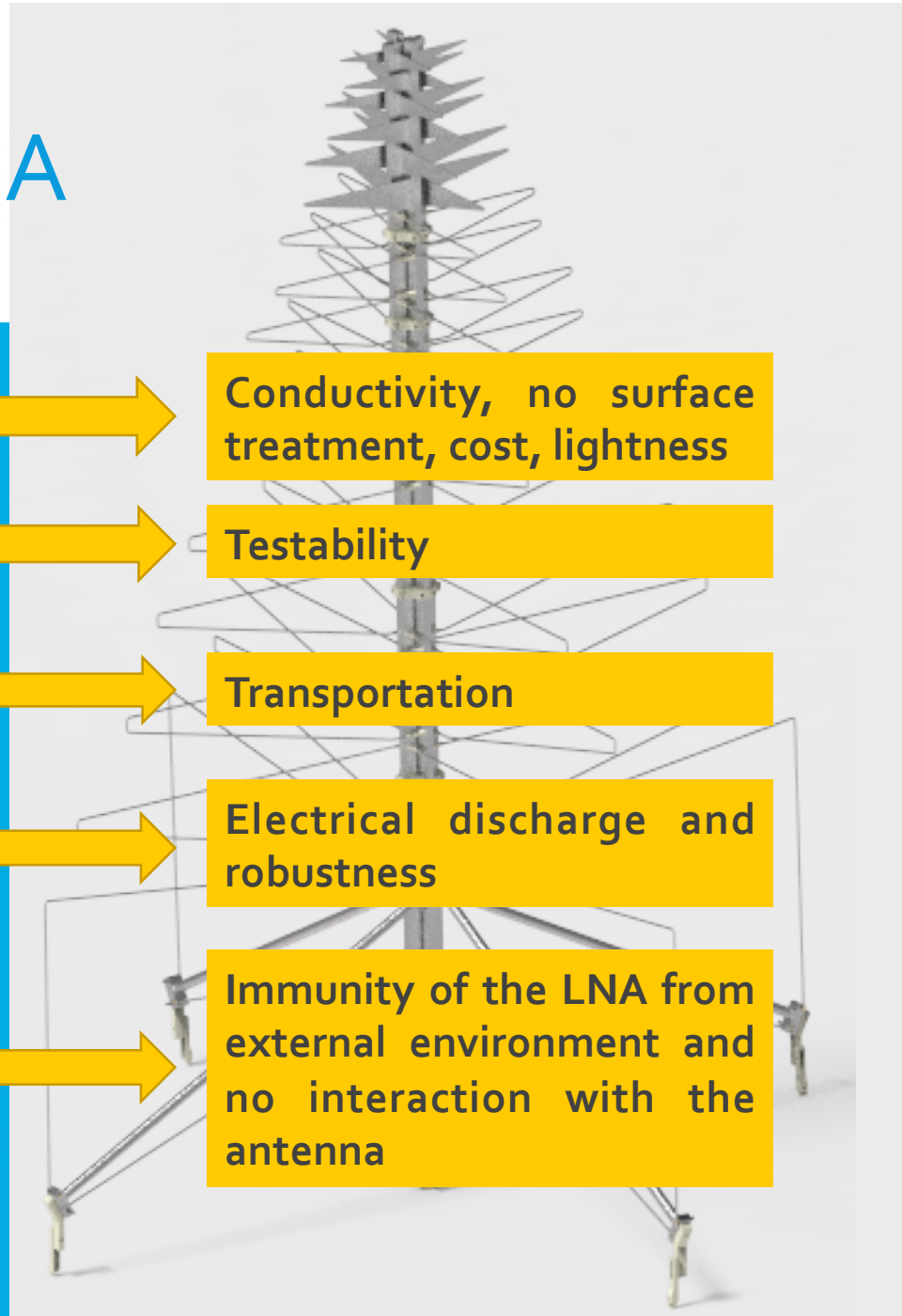
Close boom, ~16 dipoles (15 triangular), ~2 m high, 1.6 m bottom dipole, square foot-print 1.13x1.13 m

*No **Major Science Impact** in the valuation criteria defined by the SKA Office*

In September 2017, the Antenna Selection Panel identified the SKALA4 as the antenna which best serves the SKA1-LOW and recommended to bring the design to a satisfactory state.

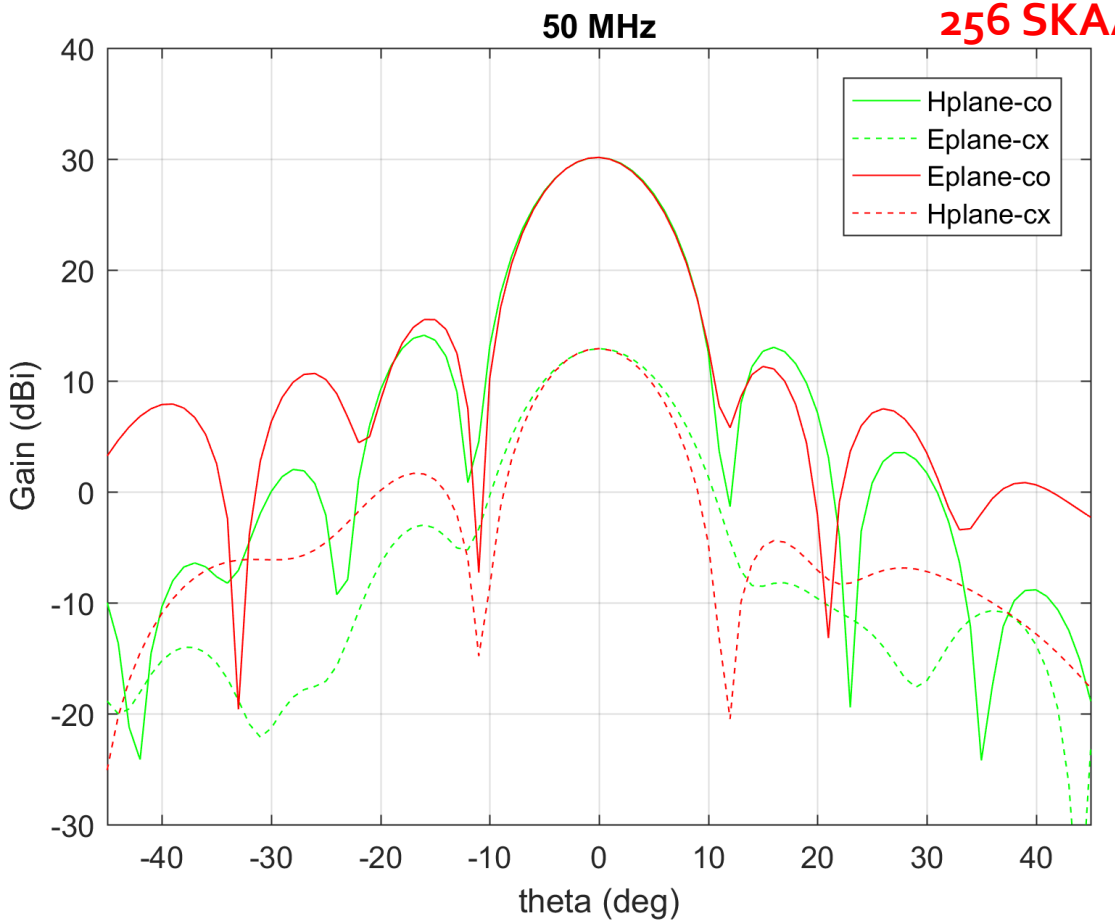
SKALA4-AL: A REAL ANTENNA

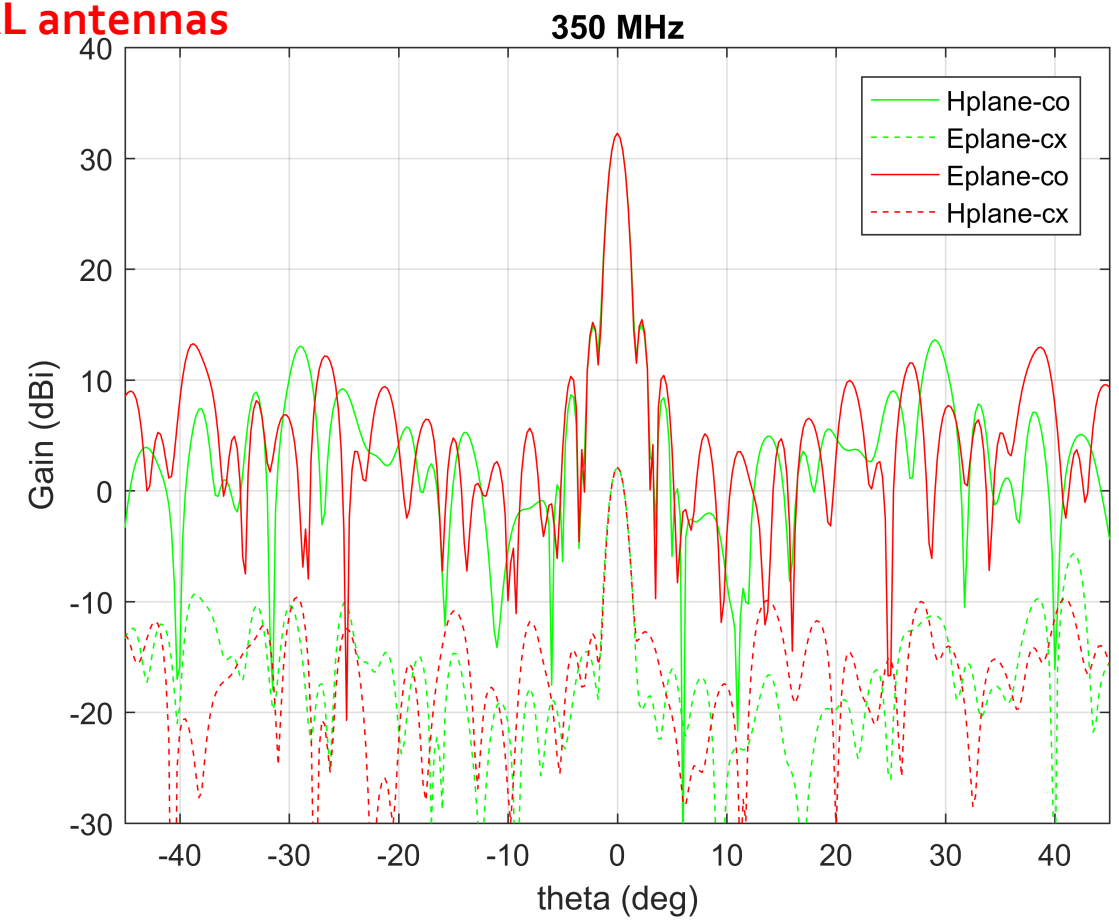
- Material: aluminium (mild steel)
- Antenna feeding: single-ended 50 ohm impedance (differential 100 ohm)
- Rectangular booms with screwed dipoles (circular booms with welded dipoles)
- Antenna electrical connection: grounded to the metallic plane with a brass central foot (isolated from the ground)
- Architecture: Two LNAs located inside the booms and Radio Frequency over Fibre (RFoF) transmitter placed after the antenna (trumpet composed by LNAs and RFoF transmitter located among the booms on top of the antenna)



EM NUMERICAL ANALYSIS

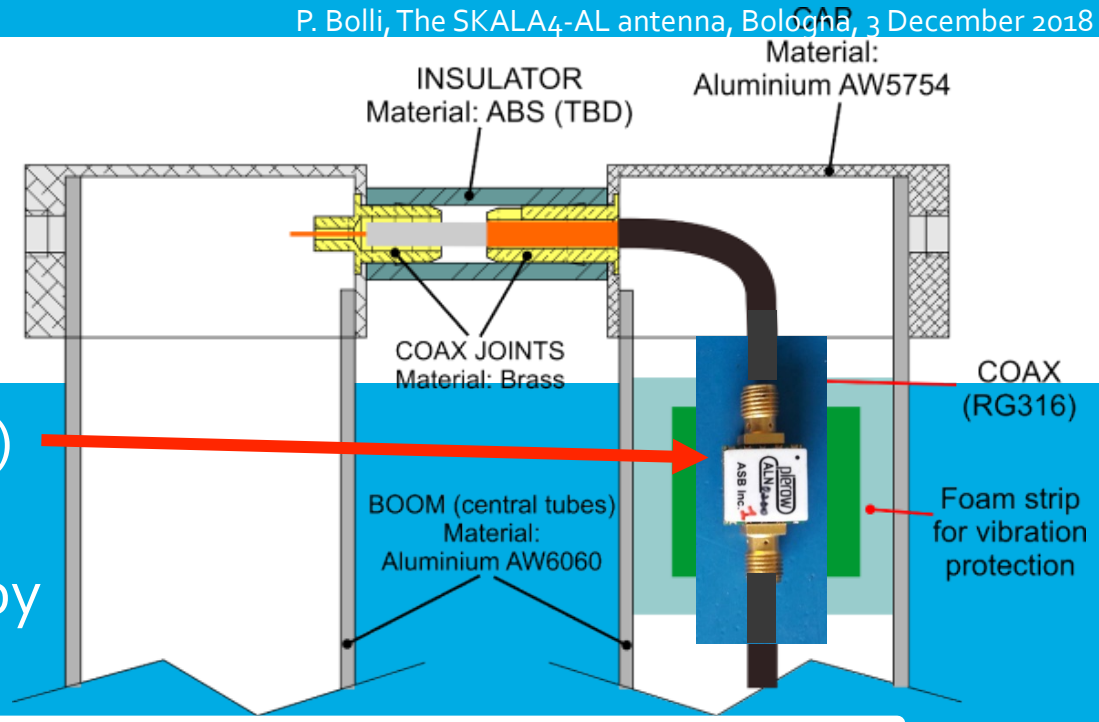
256 SKAAL4-AL antennas

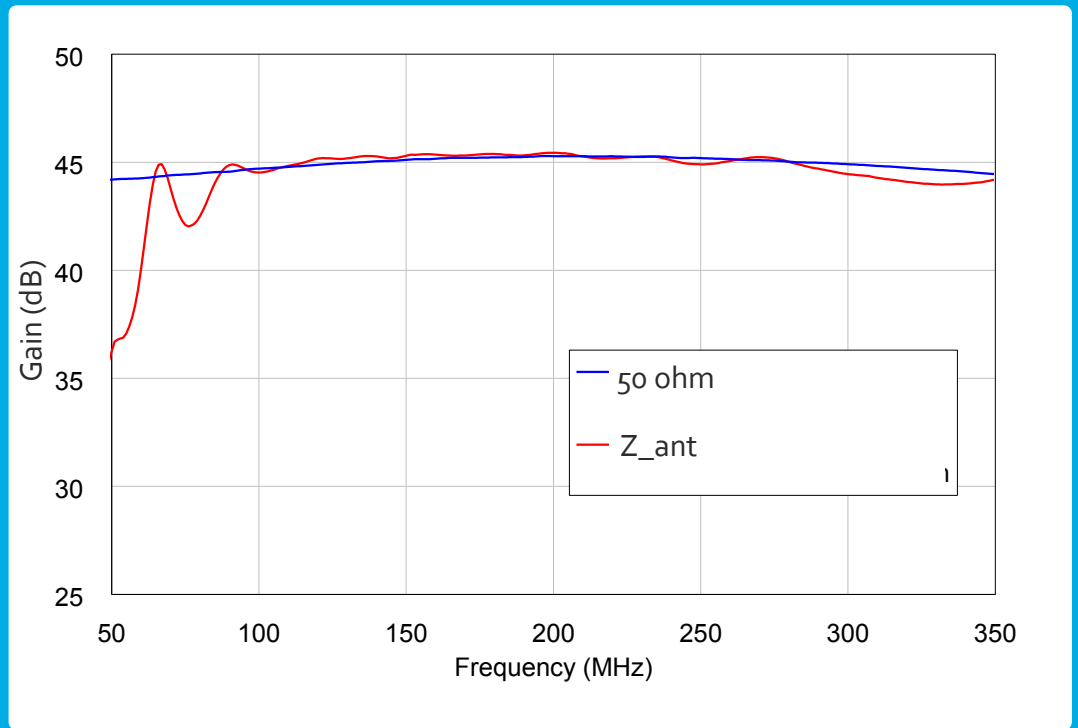


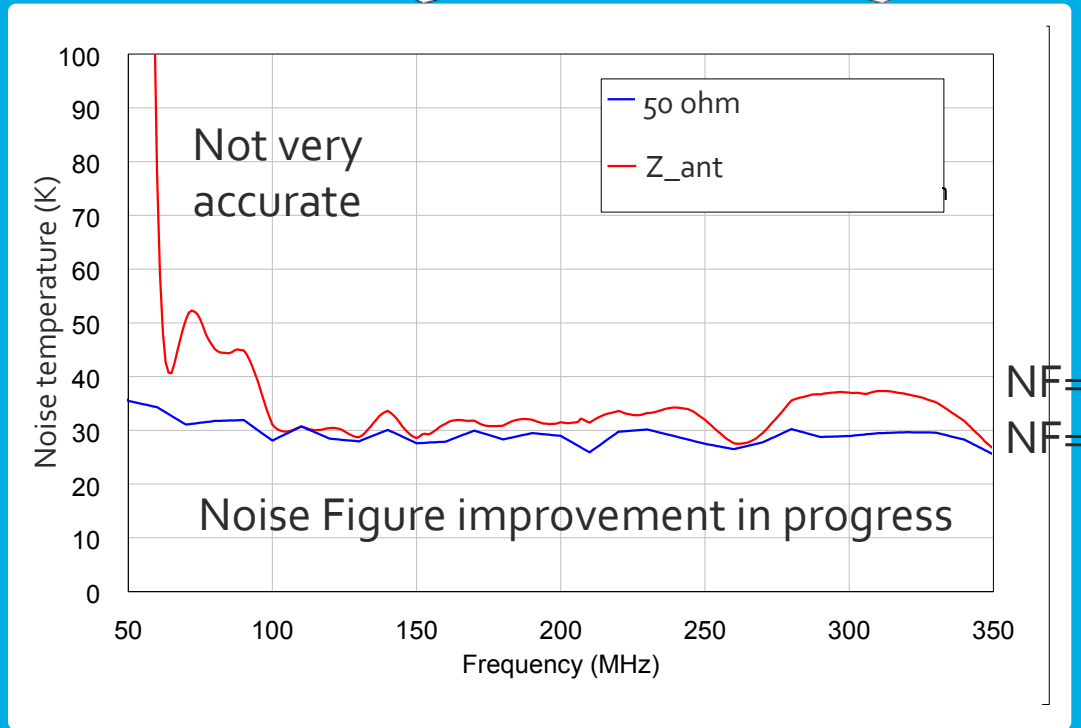


LOW NOISE AMPLIFIER

A single-ended 50-ohm double stage (gain 40-45 dB) has been developed by the industrial partner ASB (South Korea) according to the requirements given by the Italian team.

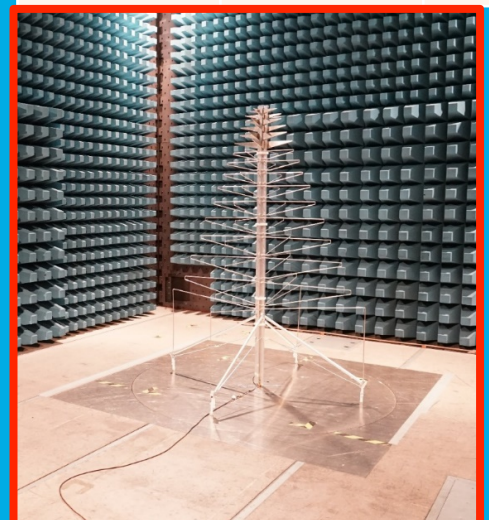


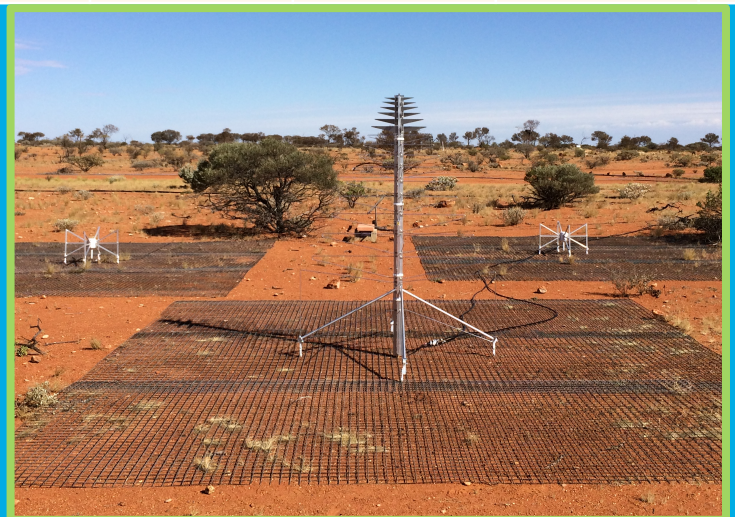


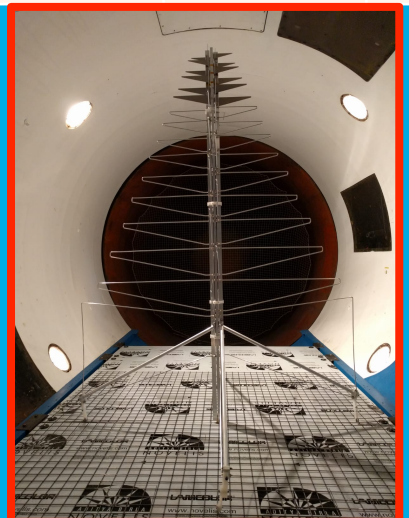


EXPERIMENTAL ACTIVITIES

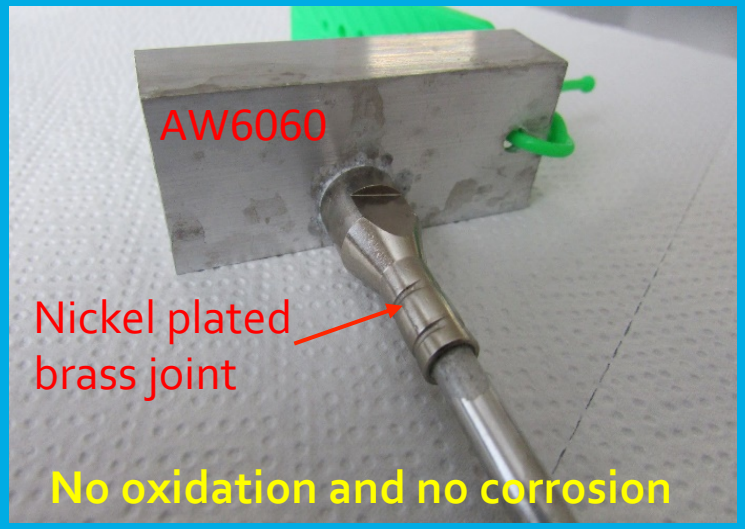
2018											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Anechoic chamber (Ferrara)	Mechanical verification (Medicina)		UAV measurement (Turin)	On-site tests (Australia)					Wind tunnel (Turin)	On-site tests (Australia)	



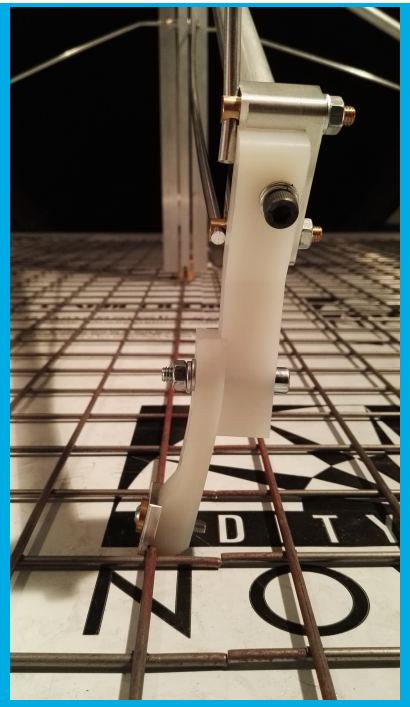




ENVIRONMENTAL TESTS

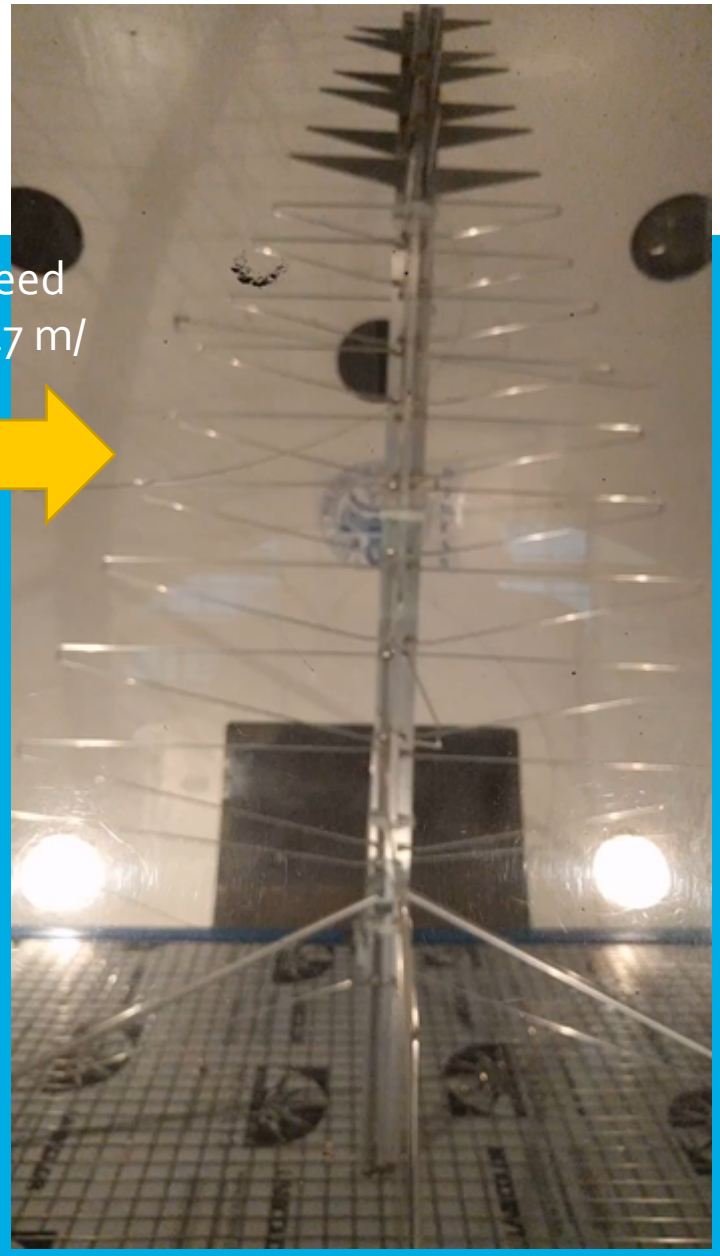


A 200 h salt spray test on the aluminum alloy and joint assemblies was performed for evaluating the antenna corrosion resistance.



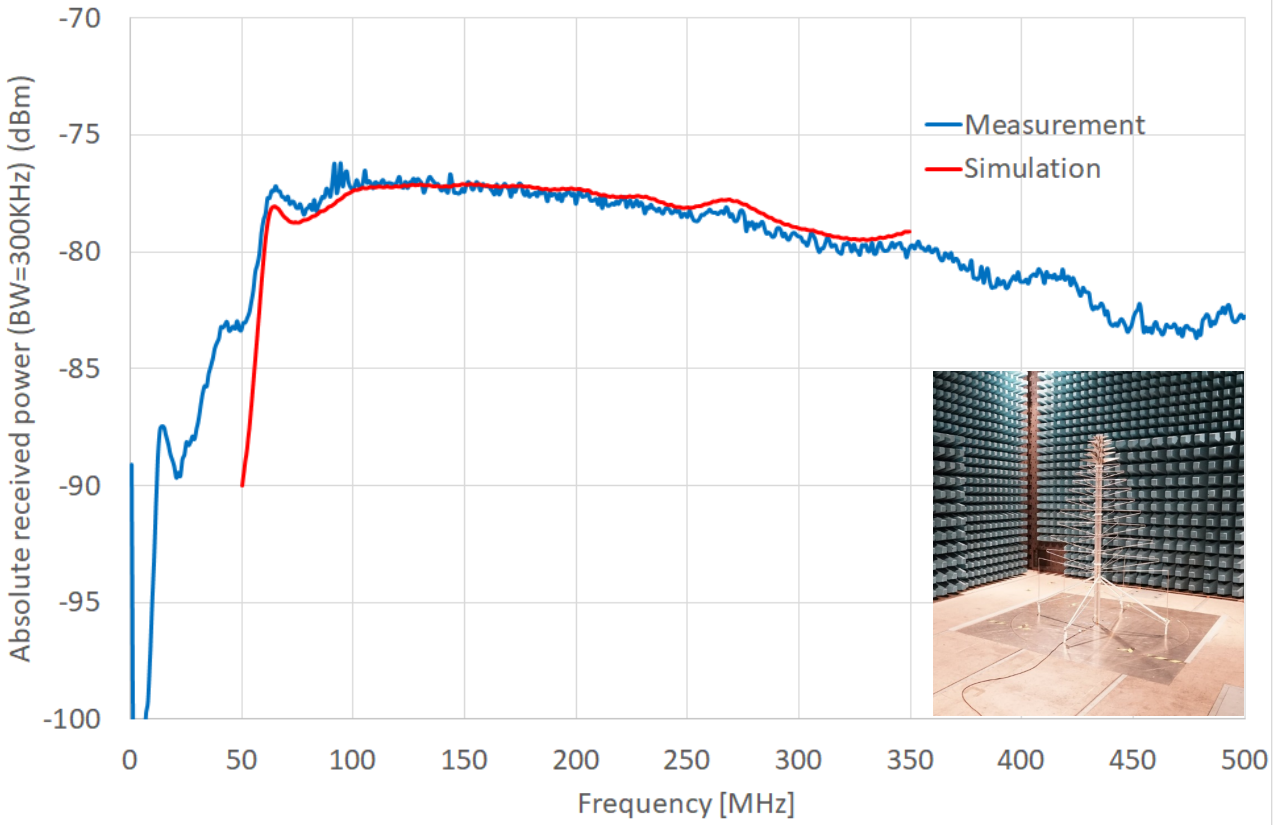
Rotation of the fixing point. This originates an inclination of the antenna and a detachment of the grid of about 40 – 50 mm.

Max speed about 27 m/ sec.

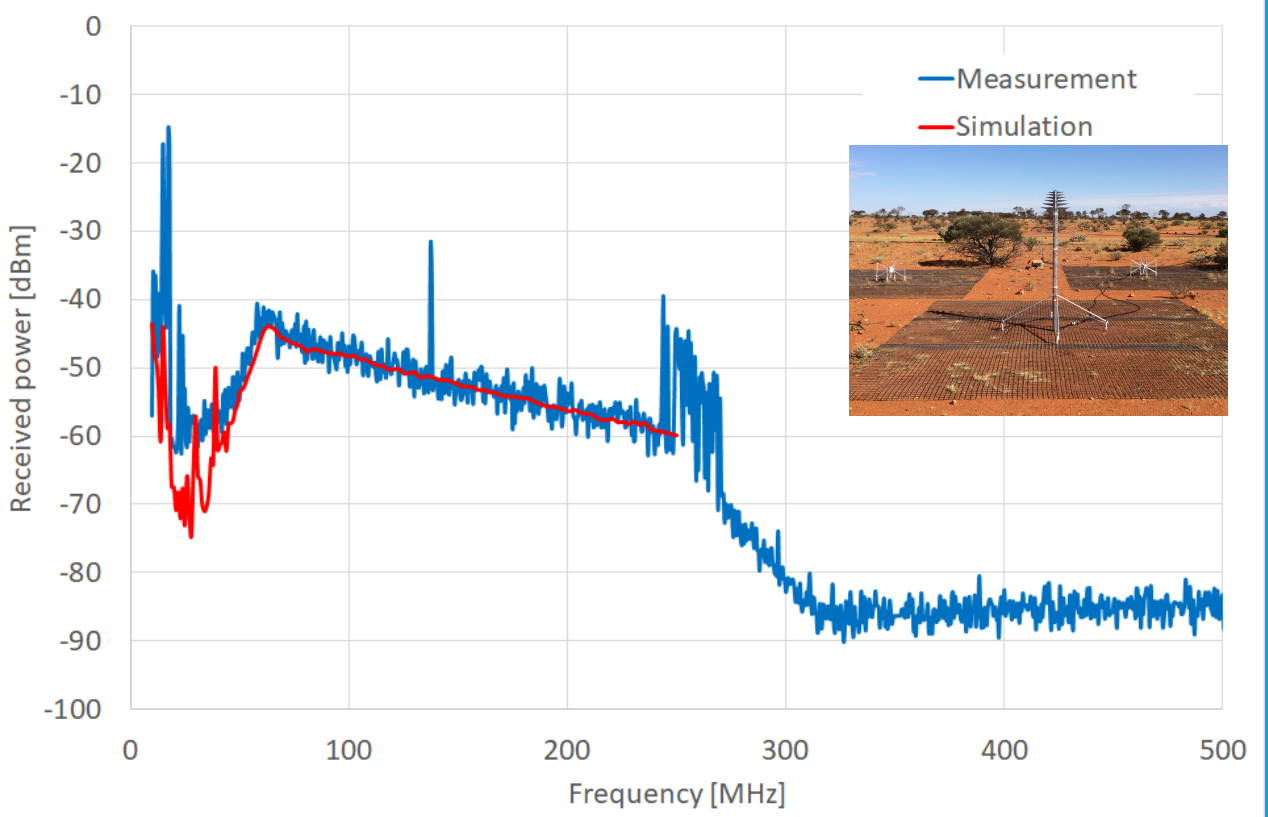


RX POWER

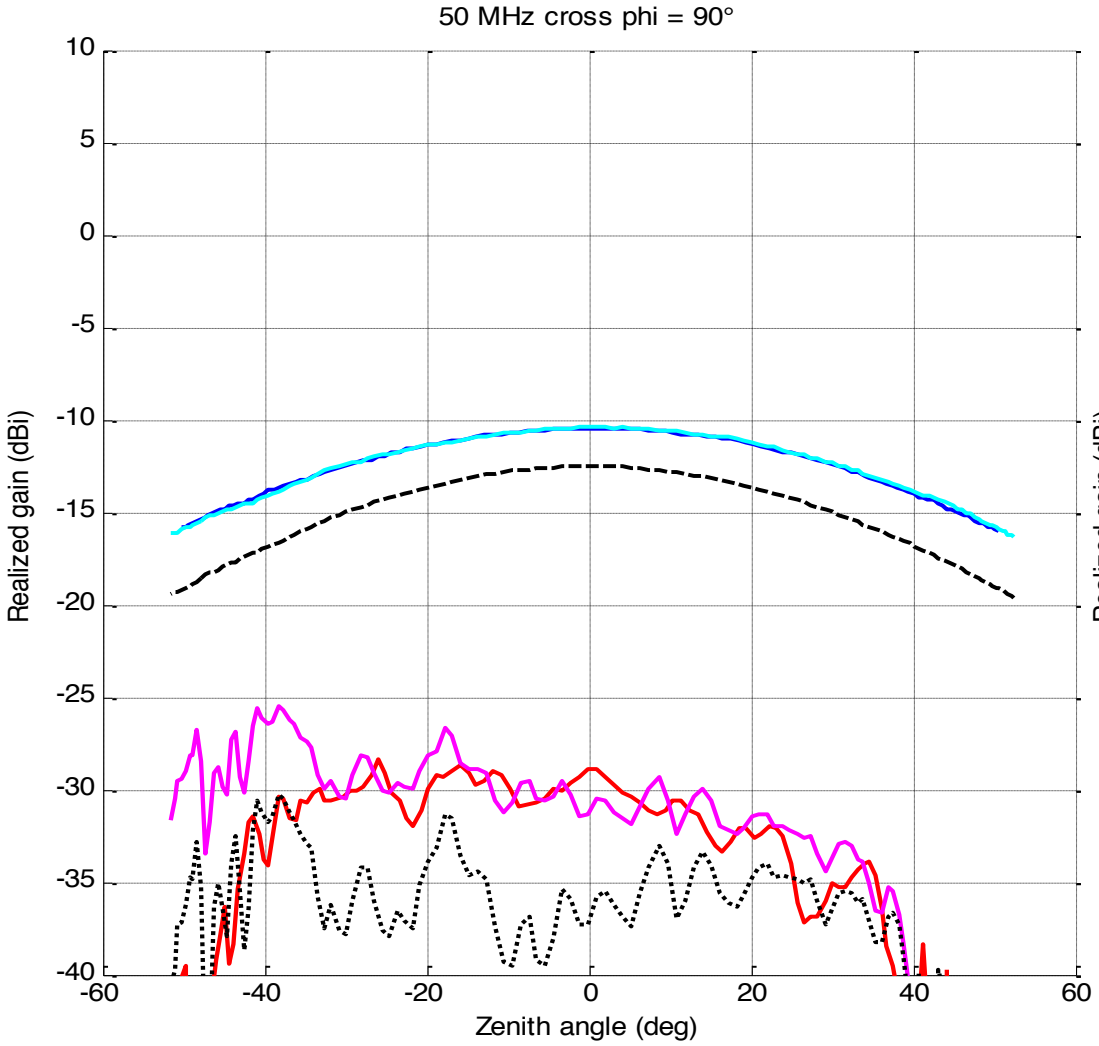
Semi-anechoic chamber - T_sky =300 K

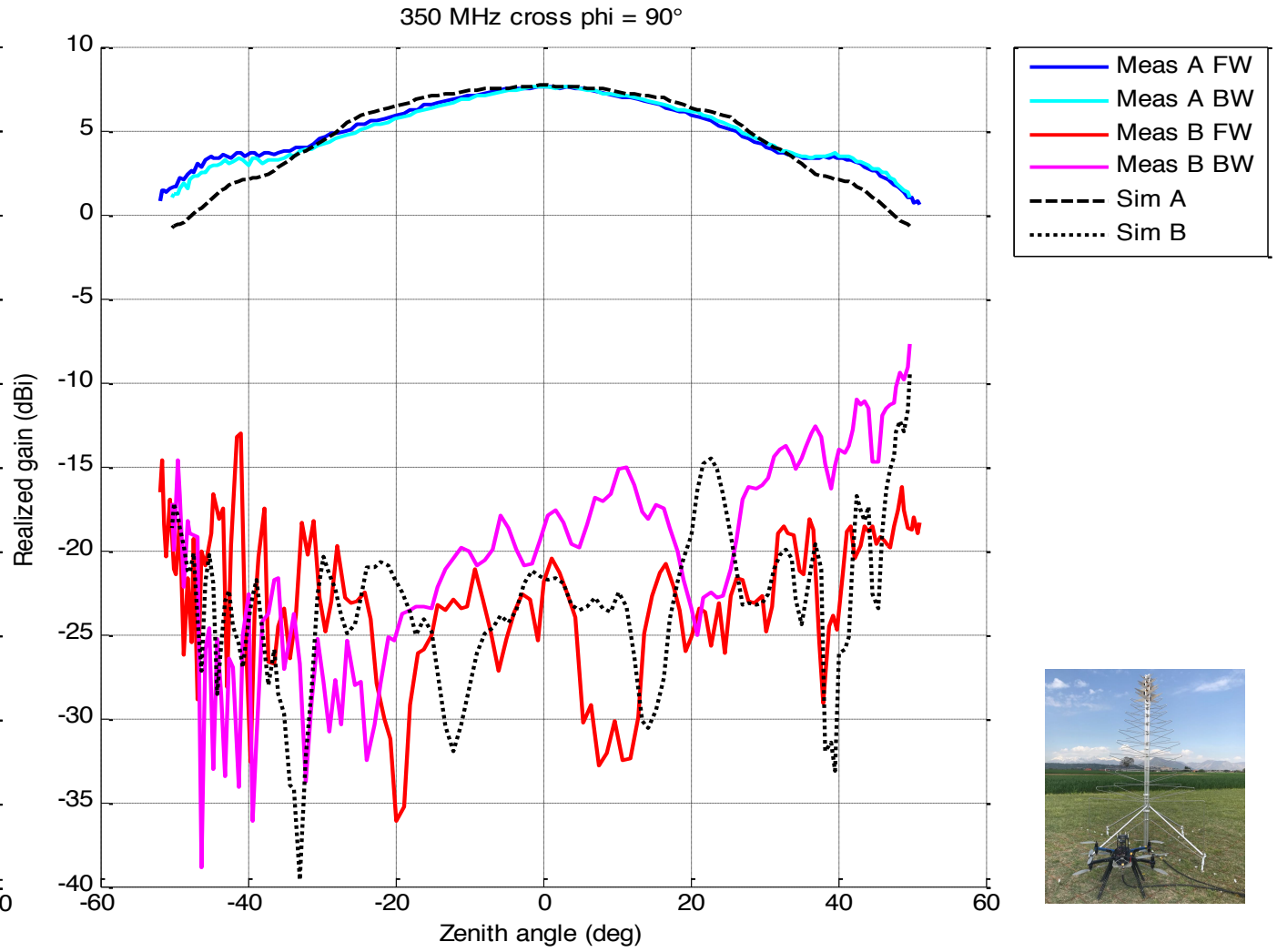


MRO site - T_sky



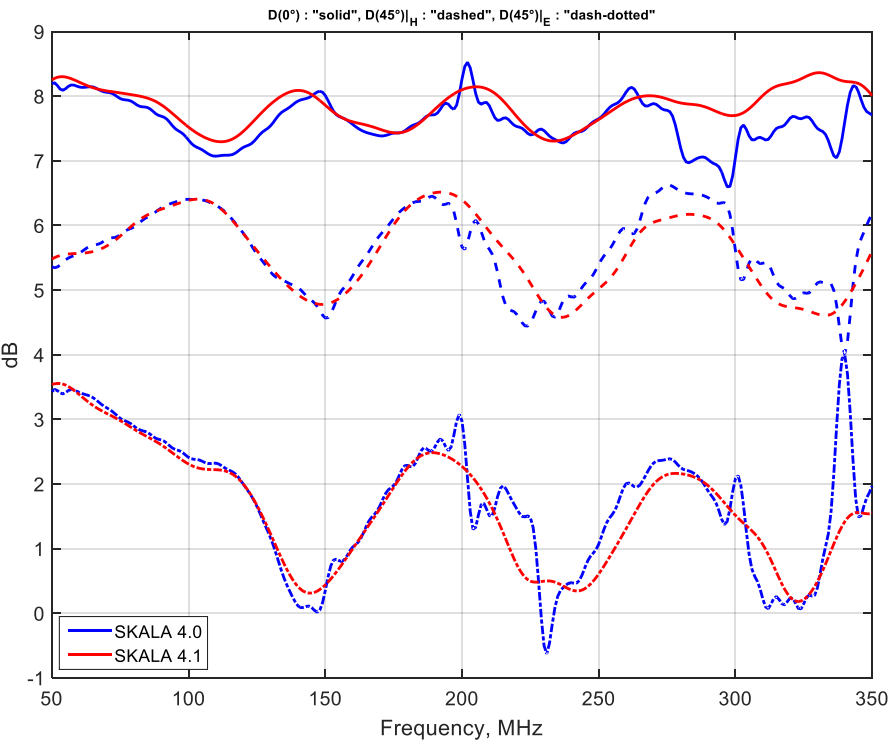
ANTENNA PATTERNS

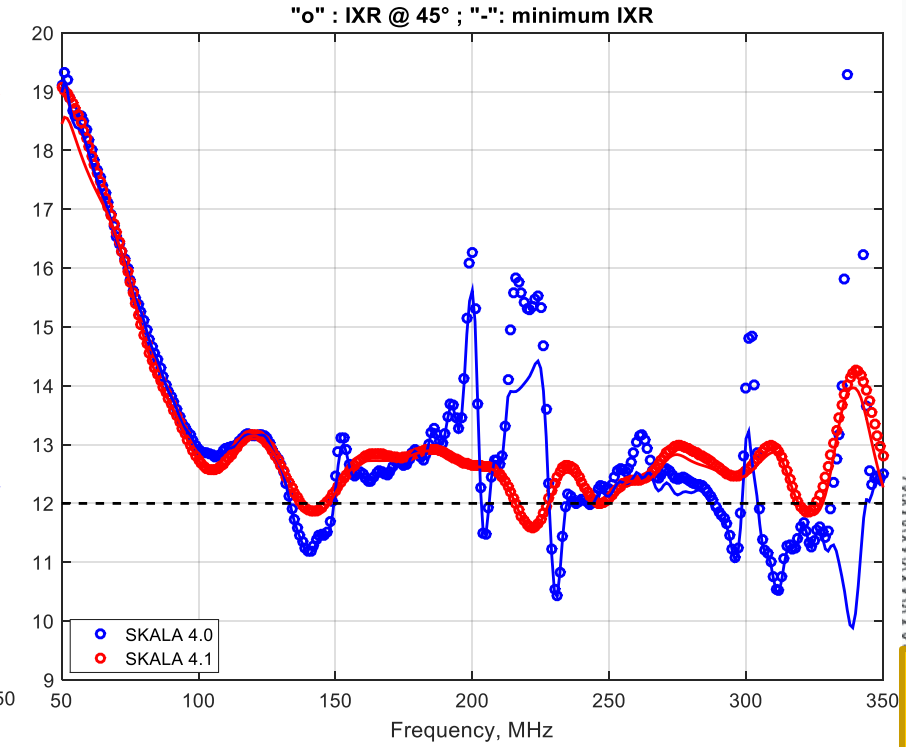




NEW VERSION: SKALA4.1-AL

The SKALA4.1-AL antenna improves the antenna sensitivity (reducing the ripple) and the IXR.

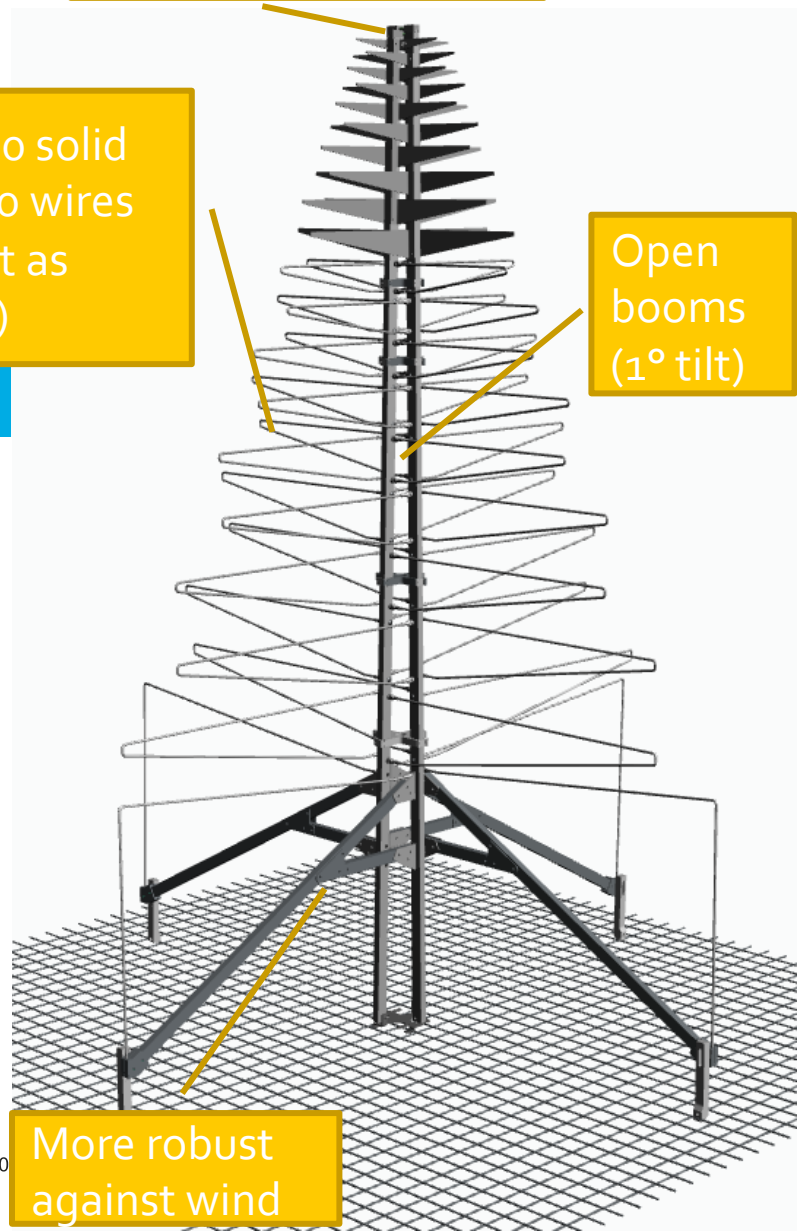




New LNA connection to the antenna feed

20 dipoles: 10 solid dipole and 10 wires (same height as SKALA4-AL)

Open booms (1° tilt)



More robust against wind

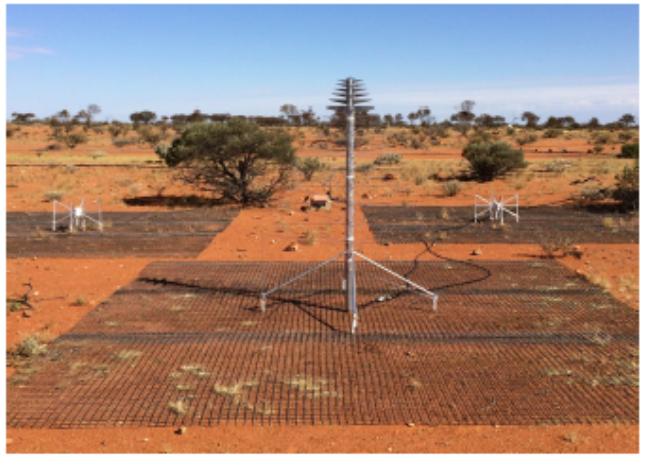
CONCLUSIONS

- The SKALA4.0-AL antenna is one of the possible implementations of the SKALA4 conceptual design.
- Two prototypes of the SKALA4.0-AL antenna have been intensively tested.
- The SKALA4.1-AL version is a new antenna currently under design to improve EM performance and mechanical aspects.
- For the **bridging phase** of SKA1-LOW, 140 or 280 (?) SKALA4.1-AL antennas will be fabricated (70 by March 2019 and the remaining ones for July 2019).

IRA Internal Report 521-18

The SKALA4-AL antenna:

implementation, prototyping and experimental verification



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QUESTIONS?