Medium-to-high gain X-band antenna with customisable pattern and polarization

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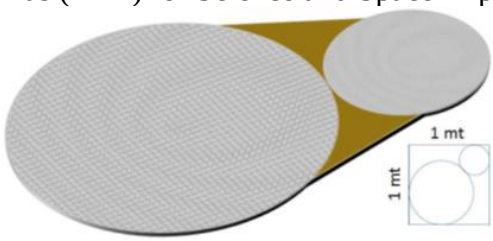
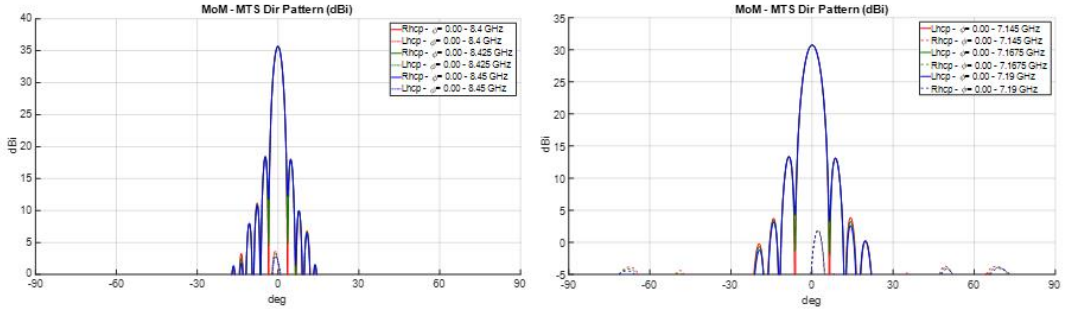
MTS antennas have emerged in recent years as a solution to realize high performance low-profile antennas, providing advantages in terms of enveloppe and weight, reduced complexity and manufacturing costs. The new technology has been demonstrated up to TRL 4, proving the unique flexibility of MTS antennas in the choice of radiation pattern and polarization using the same overall structure. These are fundamental properties for a number of space applications, including data transmission for Earth observation missions and deep-space science and exploration missions.

OBJEVTIVE AND ACHIVEMENTS OF THE ACTIVITY

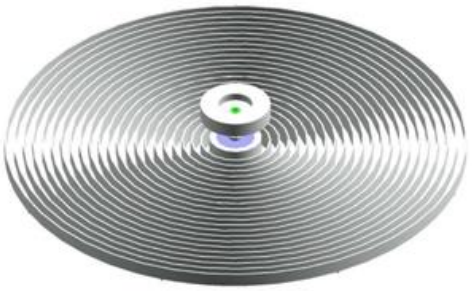
The main objective of the activity was to raise the technology of metasurface (MTS) antennas to at least TRL 5-6 by designing, manufacturing and testing a Medium-to-high gain X-band antenna. Two baseline sets of requirements have been specifically addressed in the design phase:

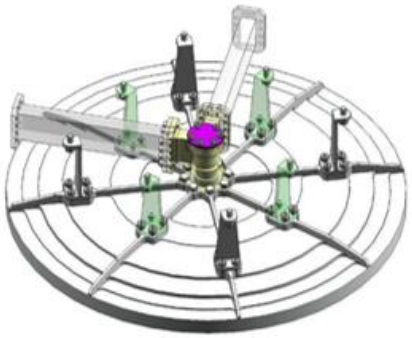
a. Pencil Beam Antennas (PBA) for Science and Space Exploration;

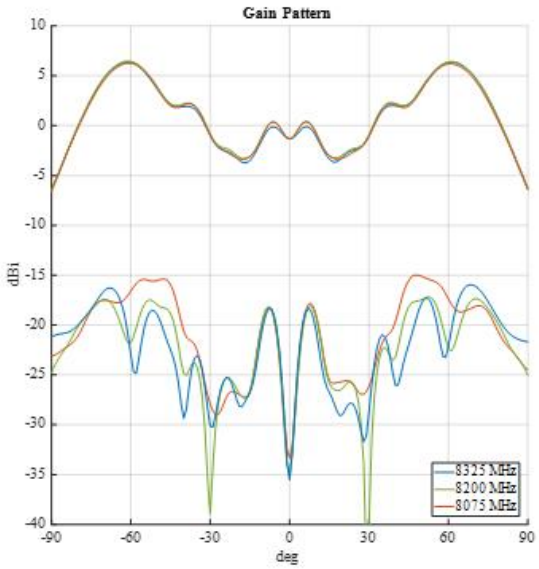




b. Data DownLink (DDL) antenna for LEO mission.







A prototype of the DDL antenna has been realized and RF, Vibration and Thermal tests are performed. A summary of the RF measurement results of the DDL antenna prototype are reported in the following table.

XPD	
X Band Tx - RHCP Port	
Frequency [GHz]	[dB]
8.075	17.9
8.095	18.3
8.188	18.4
8.2	18.0
8.224	16.4
8.26	16.6
8.293	17.1
8.325	18.0
Worst case [dBi]	16.4
Requirement [dB]	18.0
Margin [dB]	-1.6

AMPLITUDE RIPPLE IN BAND	
X Band Tx - RHCP Port	
BAND	AMP. RIPPLE
[GHz]	[dB]
8.075 ÷ 8.325	0.6
Requirement [dB]	0.5
Margin [dB]	-0.1

PHASE RIPPLE IN BAND	
X Band Tx - RHCP Port	
BAND	PHASE RIPPLE
[GHz]	[Degs]
8.075 ÷ 8.325	1.9
Requirement [Degs]	2.5
Margin [Degs]	0.6

XPD	
X Band Tx - LHCP Port	
Frequency [GHz]	[dB]
8.075	18.3
8.095	19.4
8.188	19
8.2	18.1
8.224	15.4
8.26	15.3
8.293	17
8.325	18.9
Worst case [dBi]	15.3
Requirement [dB]	18.0
Margin [dB]	-2.7

AMPLITUDE RIPPLE IN BAND	
X Band Tx - LHCP Port	
BAND	AMP. RIPPLE
[GHz]	[dB]
8.075 ÷ 8.325	0.6
Requirement [dB]	0.5
Margin [dB]	-0.1

PHASE RIPPLE IN BAND	
X Band Tx - LHCP Port	
BAND	PHASE RIPPLE
[GHz]	[Degs]
8.075 ÷ 8.325	2.4
Requirement [Degs]	2.5
Margin [Degs]	0.1

The project achieved the implementation and pre-qualification of the DDL antenna EQM-level prototype. The excellent performances of MTS DDL antenna were fully confirmed. The use of antennas based on metasurface has allowed to minimize the complexity maximizing the efficiency.

In conclusion, the study has shown the intrinsic potentiality to obtain an unequalled model of a DDL antenna able to operate in double polarization with improved RF performance wrt the existent solutions in terms of bandwidth, isoflux radiation mask compliance, XPD and ripple figure.