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THE FRENCH AEROSPACE LAB

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POST-DOCTORAL POSITION

Reference : **PDOC-DEMR-2024-01**

Hosting Laboratory at ONERA : DEMR/CAT

Branch : Physics **Location** (ONERA centre) : Toulouse

Department : Electro-Magnetics & radar

Research unit: EM sensors, antennas & microwave technology research unit

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Topic: Design, simulation and RF measurements of reconfigurable transmitarray antennas in the Ka band

Key-words: Active antennas, Transmitarray, 5G mmWaves, PIN diodes, satellite, Ka band, Arduino uno microcontroller, Field Programmable Gate Arrays (FPGA), manufacturing and RF measurements

Context:

The evolution of telecommunications standards demands advanced antenna technologies to meet the growing requirements of ultra-high-speed applications in the Ka band. These higher frequency bands pave the way for the deployment of Low Earth Orbit (LEO) constellations and promise global coverage with reliable and high data rate connections. However, this transition introduces challenges, including higher propagation losses, necessitating high-gain antennas and efficient beamforming solutions. Transmitarrays (TA) are a promising solution that has attracted considerable attention over the last decade is space-feeding antennas. These antennas offer the advantageous features of phased arrays without the necessity for complex Beam Forming Networks, thereby achieving high efficiency and minimizing losses in beamforming and beam-scanning capabilities. TAs consist of multiple discrete unit-cells illuminated by a feed source. Each unit-cell plays a pivotal role in phase-shifting the incident field to generate a controlled outgoing wave front. The key to performance lies in the design of these unit-cells. Phase control can be achieved by modulating the geometrical aspects of the unit-cell, defining a passive structure, or by incorporating electronically reconfigurable components onto the unit-cell.

The need for low-cost, wideband, and efficient reconfigurable circularly polarized TA antennas remains an open and critical area of exploration. Recent works performed at ONERA address this challenge by introducing, a novel reconfigurable circularly polarized (CP) unit-cell incorporating PIN diodes. The unit-cell employs a linear-to-circular polarization (LP-CP) conversion mechanism, enabling the utilization of a cost-effective LP feed source and the emission of a high-quality CP field through the TA aperture, thereby contributing to reduced antenna costs. Notably, the polarization conversion is integrated into the unit cell topology, eliminating the need for external polarizers.

Post-doc description (research work program):

The starting point will be a TA active antenna prototype (10cmx10cm) produced at ONERA using PIN diodes as well as diode polarization control cards using an Arduino uno microcontroller. Firstly, in order to improve the switching time of the antenna beam, innovative design of new diode polarization control cards based on FPGAs will be carried out as well as its programming to improve the beam switching time of the 10cmx10cm prototype (a patent may be proposed).

Secondly the candidate will be in charge to design an innovative diode control tracks for an antenna measuring 30cmx30cm (major research contribution to the subject), to draft the technical specifications for manufacturing a 30cmx30cm antenna which will be carried out by a subcontractor to be identified.

Finally, the measurements of gain diagrams of the developed TA antennas with static pointing will be performed in an anechoic chamber at ONERA. A publication of the research works in an IEEE journal will be written.

Deliverables and outcomes:

- Project technical reports
- Novel 10cmx10cm reconfigurable transmitarray with higher TRL (Technology readiness level)
- New diode polarization control cards
- Technical specification report for manufacturing a 30cmx30cm reconfigurable TA
- Publication of patents on the 30cmx30cm antenna concepts following by IEEE journal papers

Collaborations:
Constellation Technology (CTO) through the 5G NTN mmWave project funded in part by bpifrance

Duration: 24 months

Gross yearly salary: about 28 k€ (medical insurance included)

CANDIDATE PROFILE

Degree: PhD

Skills:

- Antennas, active components (diodes),
- Arduino microcontroleur,
- Field Programmable Gate Arrays (FPGA)
- KiCad software suite for electronic design
- C++, Python programming
- Use of commercial (CST, HFSS) and in-house simulation tools
- massively/parallel computing
- Publication capability.