Thesis subject:

Name of the laboratory: Institut Fresnel

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Financial support from CNES/DGA requested (gross salary: 1870 €)

Subject's title: RF cloaking for desensitisation of close and/or co-located antennas Application in the smallsats context.

Subject description:

The development of projects using small platforms (smallsat or nanosat), whether for constellations (Oneweb, Kinéis, ...) or short duration missions (Entrysat, MarCO, ...), leads space actors to a race for miniaturization, and to the reduction of costs, platform equipment and payload instruments.
From a radiofrequency point of view, this is not without consequences on the performance of the various telecommunication links. Indeed, this advanced miniaturisation has two complementary adverse effects:
- A decrease in available on-board power. This reduces margins and therefore requires antennas to be particularly efficient once they are on board the satellite.
- A significant reduction in the available surface area on the sides, which means that the radiating elements take up less space and are closer to each other.
This proximity can lead to a total or partial destruction of antenna performance (mismatch, pattern distortion, degradation of polarization purity, losses ...) that must be studied and compensated for. In this respect, there are in the literature some examples of strategies to solve these problems. It has been shown in [1] that the pattern of a monopole antenna disturbed by the presence of another monopoly placed nearby could be reconstructed by adding a "cloak of invisibility" around the disturbing antenna in order to make it invisible.
This promising cloaking technique [1-3] can be used in a spatial context where, on small platforms, antenna co-location is strong.
Objectives:
The objective of this work is therefore to identify and study a set of realistic scenarios of pattern perturbation by antenna co-location on a small platform. Several antenna concepts

should be studied and cloaking strategies should be proposed to reduce (or even cancel) these disturbing effects.
The case of circularly polarized helix antennas will be particularly studied because of their high use in the space domain. In general, the use of cloaking techniques for circularly polarized antennas will have to be addressed.
These "cloaking" structures will be studied analytically, then realized, measured and compared with numerical simulation. A first initial case of antennas operating in L and S band will be privileged. Other cases may be considered later.

Working approach:
- Analysis of case studies specific to space missions (e.g. a quadrifilar helix in L-band and a patch or another helix in S-band).
- Design and construction of cloaking structures for these antennas
- Characterization of the effect their cloaking effect: o By simulation (e.g. commercial and/or in-house developed codes) o By measurement (measurement of radiation patterns)

Consortium:
Academic Research unit : Institut Fresnel (Aix-Marseille Université, CNRS, Centrale Marseille)
Partner: CEA DAM Centre du Ripault - Nicolas MALLEJAC co-supervisor of the PhD
R&T CNES : Service Antennes (DSO/RF/AN)

Candidate profile:
The candidate should have a solid grounding in electromagnetism and be able to address both theoretical and experimental aspects related to the subject. Numerical simulation will also be an important component of the PhD student's work.
Students coming from masters programs such as Physics, Fundamental Physics and Applications, Applied Physics and Engineering Physics or Electronics, Electrical Energy, Automation, for example, will be studied carefully as well as students from engineering schools covering the same fields.

Bibliography:
[1] M. Barbuto, A. Monti, A. Alu, D. Ramaccia, A. Tobia, S. Vellucci, A. Toscano and F. Bilotti, "Invisible antennas for crowded radio platforms," in IMWS-AMP 2017, Pavia, Italie, 2017.
[2] Monti, Alessio & Soric, Jason & Barbuto, Mirko & Ramaccia, Davide & Vellucci, Stefano & Trotta, F. & Alù, Andrea & Toscano, Alessandro & Bilotti, Filiberto. (2016). Mantle cloaking for co-site radio-frequency antennas. Applied Physics Letters. 108. 113502. 10.1063/1.4944042.
[3] Ns, Kumutha & Kaluvan, Hariharan & Amutha, N. & Manimegalai, Bala. (2018). Review of RF Cloaking Techniques for Antenna Applications. Applied Computational Electromagnetics Society Journal. 33. 880-885.