

	2021-2022	
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Post-Doc / Research Engineer position

Subject : “Design of Smart and Integrated radio link for a 2U CubeSat”

Key words : Cubesat, integrated antenna, spatial LP-WAN

Advisors : F. Ferrero

Place : LEAT, Sophia-Antipolis, France

Context:

The **Nice Cube** Satellite is intended to serve as a **technological platform** to demonstrate and highlight innovation developed at UCA. The project has been initiated by Lagrange Lab [CSU19] through the University Spatial center (CSU) to launch the first UCA satellite in 2025 [MIL18]. LEAT has joined the project to develop the communication system integrated in the 2U structure (10 cm x 10 cm x 20 cm volume) which imply very challenging design requirements especially for RF systems. Antennas are required for TTC (Telemetry, Tracking and Control) functions or data communications. The TTC function requires a **robust** low bit rate radio link established between the CS and the ground station (GS) which should be effective even in a worst-case scenario. Thus, UHF frequency bands are preferred thanks to the good propagation properties between the GS and CS. Circular polarization (CP) is usually desired to avoid faraday effect and misalignment. This type of radiation usually required complex multiple ports feeding network to create a circular phase distribution among different antenna elements [TRI20]. Moreover, specific pattern like so-called “**iso-flux**” characterized by higher gain at lower elevation angles is needed to provide uniform signal strength at the receiver throughout the satellite pass [HEB11]. State of the art solutions are based on wire antennas (dipole, helical) [LOK17] but require a deployable mechanism **extremely risky** for the mission success.

Our innovative approach will focus on the integration of the UHF antenna directly in the structure of the 2U CubeSat. When considering integration in a small structure compared with the wavelength, a complete study including impact of the CS chassis on this antenna is mandatory to provide a **controlled radiation pattern** [NAR19]. Considering the antenna and structure interaction using characteristic modes theory will enable an optimal control on antenna integration and radiation performance.

The Nice Cube ambition is to develop smart, reliable, efficient UHF antenna for CubeSat for a 2U platform by combining advanced antenna design, innovative multi-port feeding mechanism and optimized modeling. CubAnt addresses 3 main unresolved challenges needed for cube sat antenna:

- Advanced antenna and multi-port design technique using **characteristic mode** analysis of the structure for optimal positioning and design of the antenna system
- Advance active **feeding mechanism** to provide analog beamforming capabilities
- Innovative ultra-sensitive waveform to be implement on low-power Software defined radio.

Subject :

The post-doc position will integrating advanced antenna concept developed by LEAT antenna team inside the 2U satellite. Proposed antenna concepts will be interfaced and piloted by the **RF front-end system** developed by the post-doctoral student. The post-doc will be in charge to consider radiofrequency, mechanical, reliability and energy constraints. The RF board circuit will integrate at least two RF sub-systems at 433MHz and 2.4GHz, considering components redundancy to make the system more robust to **single-event upset**. The RF front-end will have to support **doppler robust**

modulation with frequency spreading technique to tune the data-rate vs sensitivity ratio. Studied approaches will include classical chirp based (loro) and frequency hopping with Minimum Shift Keying modulation (FH-MSK). We will also investigate more original waveform based on Constant Amplitude Zero Auto-Correlation (**CAZAC**) sequences with **low-power FPGA architecture** [HES19]. **Active control** of the antenna beamforming feature will enable **noise filtering** and **extended communication range**. A pro/cons analysis will be realized in the C phase of the project to select the best compromise between the PhD and Post-doc student concepts that will be finally integrated on the Nice Cube platform.

Requirements :

The Post-doc successful candidate is expected to hold or the be about to receive a PhD in Telecommunication or Electronic Engineering. An experience in Space technologies is a requirement. A strong background in radiofrequency technology is needed with experience in low power software defined radio (FPGA). A specialization in antennas is an asset. Good command of English orally and in writing is required to publish and present results at international conference and in international journals.

Salary: Depend on work experience.

Starting date: on latest January 2021

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