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EMPOWERING STUDENT-LED SPACE EXPLORATION: DEPLOYMENT OF AN INNOVATIVE MULTI-BAND GROUND STATION FOR AMATEUR SATELLITE COMMUNICATIONS AND OPERATIONS

Abstract

The student association EPFL Spacecraft Team is currently deploying a fully automated multi-band ground station (GS) on the EPFL campus. This effort is mainly motivated by the upcoming CHESS CubeSat mission, scheduled for launch in 2027. The GS versatility opens the door to a wide range of applications, including radio astronomy or Space Situational Awareness, and benefits from a cost-effectiveness that is unprecedented to the authors' knowledge on a student project level. The GS currently operates in UHF and L-band with respective emission gains of 16.5 and 21 dBi. An additional high-gain X-band antenna is to be commissioned by Q4 2024. This improvement makes the GS compliant with the strong link requirements of the CHESS mission, allowing it to not only support both TTC down and up-links but also high-rate scientific data downlinks with an expected gain of 40 dBi thanks to its 2.4m reflector. The GS's operations are orchestrated through a centralized control room, providing a seamless and user-friendly experience for the students involved in the project. The ongoing deployment of this facility is key to creating a collaborative spirit within the EPFL space community, along with preparing rigorous sequences of operations and forming students to radioamateur procedures. The merits of this approach were demonstrated by the successful first edition of a practical work in radio astronomy integrated by the Physics department to the BSc curriculum, aiming at observing H21 radiations with the L-band antenna. This rising academic support is poised to empower the project's momentum, and more collaborations are under discussion with laboratories, amateur satellite projects and external organizations such as AmSat and SatNogs for the testing of the GS sensing devices. Leveraging on the popularity of CubeSat technologies and increasing emergence of student-led space missions, this project builds on students' motivation and external stakeholders to foster innovation. From the in-house built Alt-Az antenna pointing mechanism of the L-band reflector to the future X-band reflector's X-Y pointing mechanism and fine-tuned feed antenna, the approach proved to achieve outcomes that stand up to professional standards within a competitive budget. This publication delves into both the technical aspects and organizational structure of the GS and outlines how the space sector and more specifically the ground segment can benefit from student initiatives combined to open science and knowledge transfer proper to the associative world.