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CUBESAT MISSION DESIGN FOR CHARACTERISING THE DUAL AURORAL RADAR NETWORK (SUPERDARN) FIELD OF VIEW

Abstract

The French South African Institute of Technology at the Cape Peninsula University of Technology started a postgraduate program in Satellite Systems Engineering in 2009 and is developing its first one-unit CubeSat. The purpose of this mission is to characterise the space weather radar antenna array at the South African National Antarctic Expedition (SANAE) base in Antarctica, with an on-board HF beacon radio transmitter. The SANAE radar forms part of the SuperDARN (Dual Auroral Radar Network) project, which consists of 16 element phased array antennas that are spread over both the northern and southern hemispheres. They operate in the HF band between 8 to 20 MHz and are used to monitor polar convection by measuring coherent scatter echoes from irregularities in the ionosphere. Accurate determination of the direction and range of the echoes received by the radar is crucial in creating polar ionospheric convection maps that are used to infer the coupling of the Earth's magnetic field with the interplanetary magnetic field in the solar wind. The phased array antenna can be steered in 16 distinct directions with each beam having approximately a 3.3^o beamwidth and spanning an azimuth sector of approximately 52^o.

The HF beacon is being developed in collaboration with the Hermanus Magnetic Observatory in South Africa. The beacon signal will be used as an active target source to enable the determination of the phase response of the array, thereby determining the direction-of-arrival of the signal. This will allow the experimental verification of the antenna's beam pattern. The beacon signal will be generated by an RFID transceiver, operating in the HF band, with a maximum output power of 150 mW. The antenna is a long thin electrical conductive tape that will be deployed from the satellite after launch. Dynamically, the antenna produces a gravity gradient torque which will stabilise the system with the tape pointing towards Earth. As the antenna is electrically small, it will have the classic figure of eight antenna pattern with the radiation null approximately towards the centre of Earth. An orbital analysis is required in order to determine how the chosen orbit will affect the coverage of the array field of view. Position determination of the satellite will be provided by an onboard GPS module.

The mission and systems design, including the link budget calculations and expected pattern measurement accuracy, will be presented. The mission launch is planned for the second quarter of 2012.