25th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Missions Global Technical Session (9-GTS.5)

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OPERATIONAL EXPERIENCE WITH A NANOSATELLITE SCIENCE MISSION

Abstract

On 25 February 2013 the first Austrian satellites TUGSAT-1/BRITE-Austria and its sister satellite UniBRITE were launched. They are part of the world's first nanosatellite constellation, called BRITE (BRIght Target Explorer), dedicated to the observation of the brightness variations of massive luminous stars. The constellation consists of five nearly identical spacecraft from Austria, Canada and Poland. Despite a design lifetime of two years the spacecraft with a mass of about 7 kg are in healthy conditions and are continuing to deliver science date with unprecedented quality. The Austrian BRITE satellites are operated on a continuous basis from the ground station at TU Graz, the Polish ones from Warsaw and the Canadian satellite from Toronto. The S-band/UHF ground stations are fully compatible and interoperable via the Internet, thus allowing operations of any spacecraft from any other station remotely. 30 star field observations, typically lasting for 100 days have been completed, 5 are currently on-going. 450 stars have been observed so far and 3.5 million photometric measurements been made by BRITE Constellation. The selection of star fields is in the hands of the Executive BRITE Science Team (BEST), the operational teams are responsible for mission planning, configuration and control of the spacecraft. Although the CCD sensors of the spacecraft experience degradation by radiation, a method called chopping was introduced to mitigate these effects. Images are taken with a slight tilting of the spacecraft and camera between exposures, then subtraction of the images minimises the effects of hot pixels and warm columns. Although the design and testing did not strictly follow ECCS standards, care was taken not to compromise on testing. Especially, substantial effort was dedicated to system-level testing, often under-respresented in nanosatellite projects. Also 1000 hours of burn-in tests were carried out. Since BRITE uses the Science S-band in downlink at rates up to 256 kbit/s and amateur radio UHF spectrum in the uplink, interference problems started in late 2013. These problems were cured by changing the communications protocols and upgrading of the ground station. The paper describes the spacecraft design, the testing and verification philosophy, the operational experience and presents measurement data on the electronics and battery status, the thermal behaviour and communications parameters. The BRITE mission demonstrates that challenging scientific requirements can be met by small and relatively inexpensive spacecraft with a lifetime comparable to traditional missions.