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ON-ORBIT PERFORMANCE OF THE BRITE NANOSATELLITE ASTRONOMY CONSTELLATION

Abstract

In 2013, the first three satellites of BRITE-Constellation, believed to be the world's first satellite astronomy constellation, were placed into orbit. To be eventually composed of six cooperating nanosatellites, BRITE-Constellation's mission is to survey the most luminous stars in the Earth's sky. In the push to observe ever fainter objects, these apparently bright stars, despite being prominent members of our most familiar constellations, have been poorly studied and are not well understood. Typically massive and short-lived, through their turbulent lives and via their violent deaths as supernovae, these stars dominate the ecology of the Universe and are critical for the formation of planetary systems and organic life. Using three-centimeter aperture telescopes for photometry, BRITE-Constellation is now measuring brightness variations, in two colours, at the milli-magnitude level, a precision at least 10 times better than currently achievable from the ground.

Comprised of nearly-identical 7kg nanosatellites, BRITE-Constellation was designed by the University of Toronto, Institute for Aerospace Studies, Space Flight Laboratory (UTIAS-SFL) of Canada. Each of three countries, Austria, Poland, and Canada, funded two satellites. Three of these satellites were integrated and tested in Austria and Poland under the guidance of SFL, while the other three were built at SFL. Through this international collaboration, the constellation boasts not just the smallest astronomy satellites ever flown, but also the first Austrian spacecraft and the first scientific satellites for Poland. Further, due to the low-cost nature of the satellites and the inherent expandability of the mission, at least six other nations have expressed serious interest in contributing additional satellites. As a result, this already uniquely successful mission could become an even greater international phenomenon and commercial outlier in the years to come.

Due to inherent resource constraints, performing a mission of BRITE-Constellation's scope on the nanosatellite scale was particularly challenging. Especially challenging was the need to point the telescope with an accuracy and stability never previously achieved with a spacecraft so small. Enabled by advances in miniaturized technology, precise characterization and tuning of attitude hardware and novel estimation and control techniques, BRITE-Constellation is now pushing the nanosatellite performance envelope by achieving three-axis pointing at the sub arc-minute level, an advance which has helped ensure the constellation will provide substantial scientific return on investment going forward.

This paper describes the goals, key design and operational challenges, on-orbit performance, and early scientific results of this mission. Future expansion beyond the baseline mission is also described.