66th International Astronautical Congress 2015

22nd IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Earth Observation Missions (4)

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DRAG-FREE TECHNOLOGY ON A SMALL SATELLITE

Abstract

A satellite is considered drag-free when it is freed of all forces other than gravity and thus flies a geodesic orbit. The first drag-free satellite, TRIAD I, was launched in 1972 to improve satellite navigation. Since then only a few other missions implemented drag-free technology, Gravity Probe B (2004) and GOCE (2009). The main application for drag-free satellites are in geodesy and fundamental physics (gravitational wave detection).

For geodesy applications a constellation of satellites with mixed orbits would improve both the temporal and spatial resolution and reduce aliasing. To make such a constellation feasible, the cost and complexity of each satellite has to be reduced.

This paper will present the path to a satellite mission on a SaudiSat bus ($100\,kg$ class) with a drag-free sensor developed at Stanford. The first satellite, a technology demonstration, was launched in June 2014 to demonstrate charge control with UV LEDs. First results of the in-orbit performance are presented. The second satellite is planned to launch into a low-earth orbit in 2017 with the goal to demonstrate state of the art drag-free performance at $10^{-12}\,ms^{-2}Hz^{-1/2}$ @ $1\,mHz - 1\,Hz$ and perform geodesy measurements.

In addition to the UV LED based charge management system, the second satellite will demonstrate other components developed at Stanford: a displacement sensor to detect the position of the free floating test mass with a sensitivity of better than $20\,nmHz^{-1/2}$ at the frequency band of interest, a caging system using a shape memory alloy actuator to hold the test mass in place during the spacecraft launch and release it into a geodesic orbit once the satellite has reached its desired orbit, a passive and active thermal control system to maintain the temperature of the payload to within $1\,mK$ at $1\,s$ and $10\,mK$ at $1000\,s$ and keep temperature gradients below $10\,mK$, and a robust control system to maintain the relative position of the satellite to the test mass. The latest results of these technologies are presented.