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FALCONSAT-7: A DEPLOYABLE SOLAR TELESCOPE MISSION

Abstract

The United States Air Force Academy (USAFA) in Colorado Springs, Colorado has the mission to, "Educate, train, and inspire men and women to become officers of character motivated to lead the United States Air Force in service to our nation." Upon graduation, cadets receive both a Bachelor of Science degree and a commission in the United States Air Force.

The Physics Department at USAFA is the program integrator for a mission called FalconSat-7 that is an innovative scheme to perform space-based imaging with a 0.2m diameter, high resolution telescope deployed from 1.5U of a 3U (10x10x30cm) CubeSat. The telescope will perform narrow-band imaging of the Sun at the hydrogen-alpha wavelength.

The main objectives for the program are:

- Cadets learn space by doing space
- Get flight heritage on a polyimide photon sieve
- Determine the imaging performance of a photon sieve in space
- Image the sun in the hydrogen alpha band in order to examine the chromosphere
- Deploy a photon sieve from a folded configuration

The 0.2m diameter telescope relies on a new enabling technology consisting of a deployable structure that supports a large flat membrane under tension. The membrane is a Photon Sieve (PS) – a flat diffractive element that consists of billions of holes. The sizes and positions of each hole are configured such that transmitted light is diffracted to a focal plane where a conventional camera is located. The PS has several advantages over that of a primary mirror or lens used in traditional imaging systems. First, the material is made on a flexible membrane that can be folded. This allows for deployed apertures with a diameter larger than that of the characteristic size of the satellite bus. Second, the PS surface requirement is around two orders of magnitude less stringent than that of traditional optical surfaces. Third, the PS is extremely lightweight, compact and inexpensive while at the same time capable of high resolution imaging of distant objects. A structure has been designed capable of deploying the photon sieve from the end of the CubeSat. The deployment structure must be extremely stable (in the microns range) when deployed and the use of a determinate, post-tensioned lanyard system, suspended from pantographs has been designed.

We focus our discussion on the current status of the payload (named Peregrine) design and development to include the photon sieve, deployment system, optical bench, and payload electronics.