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THE DELFT DEPLOYABLE SPACE TELESCOPE PROJECT

Abstract

There is a need for cheaper, lighter and smaller telescopes imposed by the on-going trend to deliver more refined Earth observation data at a lower price. Evident reasons to incorporate deployable telescope structures are firstly to fit in a launcher and secondly to decrease launch mass and volume. The Deployable Space Telescope (DST), being developed at the Delft University of Technology, aims to reduce volume (>4 times) and mass (<100 kg) by using innovative deployable optics. The WorldView-4 satellite was chosen as benchmark for its development. The DST concurrent systems design approach is driven by strictly compliant bottom-up versus top-down systems engineering.

The coarse alignment budget is treated as a one-off deployment precision performance, with the drift and stability budgets as low and high frequency stability margins. Most critical subsystem is the first DST mirror M1: its position has to be accurate up to 2 μm in all directions whilst the tilts shall be within 2 μrad. In orbit the dynamic thermo-mechanical conditions require these parameters to be within 5 nm position and 10 nrad tilt as stability budget. The M1 calibration and actuation is controlled by a wave front error algorithm. A novel actuation system, implementing the active optics strategy, is mounted on the mirror support structure. The allowable deployment errors in tip, tilt and piston are 16, 10 and 13 μm whilst the actuation precision is 51, 32 and 10 nm.

To support these critical budgets the development and testing of the first key DST hardware comprises a 3D printed COmpliant Rolling contact Element (CORE) hinge design. Hinges of this design were not applied in space so far. A good mechanical hinge design for high-precision deployment is identically one that exhibits low-hysteresis response to load cycling. The hysteresis was tested by a technique called Digital Image Correlation, which is normally used to detect micro-cracks in composite layers. The test setup proved to be very suitable for the hysteresis characterisation with a precision down to 100 nm. The maximum hysteresis found was 0.3 m for over 50 load cycles. The CORE hinge design is currently tested for hysteresis response and thermal gradient behaviour.

This paper describes the status of the optical, thermo-mechanical and active optics systems design showing that the DST is a healthy system concept.