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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 $2\ \mu\text{m}$ in all directions whilst the tilts shall be within $2\ \mu\text{rad}$. In orbit the dynamic thermo-mechanical conditions require these parameters to be within 5 nm position and 10 mrad 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 $13\ \mu\text{m}$ 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.