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PLATO SPACECRAFT: OPTICAL BENCH DEMONSTRATOR FOR THE CHARACTERIZATION OF THERMO-ELASTIC STABILITY

Abstract

The primary goal of PLATO (PLAnetary Transits and Oscillations of stars) is to open a new way in exoplanetary science by detecting terrestrial exoplanets and characterizing their bulk properties, in particular focusing on planets orbiting in the habitable zone of Sun-like stars. The measurement principle of PLATO is to carry out long (months to years), uninterrupted photometric monitoring in the visible band of very large samples of bright stars (>15.000 with $m_v < 11$) with a maximum random noise of 34ppm in one hour. The resulting light curves will be used for the detection of planetary transits, from which the planetary radii will be determined, and for the asteroseismology analysis to derive accurate stellar parameters and ages. The instrument provides a wide field-of-view (FoV) of more than 2200 deg^2 to maximize the number of the sparsely distributed bright stars in the sky with one pointing. In addition, it provides the photometric accuracy to detect Earth-sized planets and a high photometric dynamic range. This performance is achieved by a multi-telescope instrument concept, composed of twenty-six cameras, which is novel for a space telescope. Twenty-four cameras ("normal cameras") are arranged in four groups of six. Each group has the same field-of-view but is offset by a 9.2° angle from the payload module +Z axis. Two special cameras ("fast cameras") are used to provide the pointing reference for the measurements and the spacecraft attitude control. One important contribution to minimize the measurement noise is to keep the LoS of all cameras stable over a broad frequency range, with special focus on the Hz area. Therefore, very stringent requirements are imposed on the optical bench (OB) thermo-elastic stability. Their verification constitutes one of the most challenging aspects in the spacecraft qualification. The paper focuses on the Thermo-Elastic Distortions (TED) verification plan that is being implemented. The plan includes the construction of an OB demonstrator, which is tested in a flight equivalent environment, in order to have a full characterization of the TED behavior, that is then used as reference for the correlation with the results of numerical analyses. The test approach is described in the paper, including high accurate interferometry and videogrammetry to allow for a sufficient deformation measurement accuracy.