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HEATER-INDUCED THERMAL EFFECTS ON THE DRAG FREE TEST MASSES OF LISA PATHFINDER

Abstract

The ESA's LISA Pathfinder (LPF) mission is intended to set a pair of Test Masses in nearly pure free fall conditions and make very precise interferometric measurements of displacements between them, so as to pave the way for the future LISA mission, which is aimed to establish the first space-borne gravitational wave detector. In order to achieve such an objective, it is necessary to characterize and model the disturbances that will appear. Amongst the different physical effects that will appear onboard, temperature fluctuations in the Test Masses environment are expected to generate disturbances on the interferometer readouts. Therefore, these disturbances must be known and controlled and consequently a simulator of the whole LPF is being developed to provide a validation tool for the mission operations telecommanding chain, as well as for a deeper understanding of the underlying physical processes happening in the LTP (LISA Technology Package), the instrument hosting the Test Masses.

In this paper, we report on the latest progress in the analysis at IEEC of the LTP response to thermal signals injected by means of heaters. More specifically, a model to determine forces and torques on the Test Masses due to the activation of the different LTP control heaters is presented. Transfer functions relating heat input signals to temperature increments on the Test Masses in the LTP frequency band, from 1 mHz to 30 mHz, are determined. Following, the geometry of the system is studied and discretised to calculate the forces and torques that appear through different thermal effects, as the radiometer effects and the radiation pressure effect. Finally, the algorithm is implemented and some experiments from the EMP (Experiment Master Plan) are simulated to evaluate the associated dynamical effects on the Test Masses. A complete thermal model of the entire LPF spacecraft plus payload, elaborated and maintained at European Space Technology Centre (ESTEC), was used to obtain temperature distributions in response to heat inputs at prescribed spots (heaters).