IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures Control, Dynamics and Microdynamics (4)

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SIMULATION AND EXPERIMENTAL INVESTIGATION OF CALLISTO'S LANDING LEG DEPLOYMENT DYNAMICS

Abstract

DLR, JAXA, and CNES are jointly developing and building the VTVL (vertical take-off and vertical landing) first stage rocket technology demonstrator CALLISTO (Cooperative Action Leading to Launcher Innovation in Stage Toss-back Operations). One objective of CALLISTO is to demonstrate the landing leg deployment and subsequently a successful touchdown by means of a deployable four leg landing system, called the Approach and Landing System (ALS). Here, the deployment phase is critical for the re-usability mission objectives, because an unsuccessfully deployed landing system will cause a loss of the vehicle. The transient phase from stowed to deployed configuration is conducted shortly before touchdown. During this phase an asymmetric load environment is generated by the aerodynamics and vehicle dynamics, and introduced into the ALS landing legs. Additionally, these loads generate disturbance torques and forces that are acting on the vehicle and needs to be compensated by the GNC prior to touchdown. This harsh and unsteady external load environment challenges the pneumatic deployment subsystem of the ALS. For the purpose of the investigation of the complex interplay of aerodynamics, vehicle's approach trajectory, ALS system parameter and the landing leg deployment dynamics, a numerical simulator has been developed. In order to increase the prediction accuracy of the simulator an excessive single leg deployment test campaign has been performed in the DLR Landing Mobility Test (LAMA) facility. Both, the studied deployment dynamics and the conducted single leg deployment test campaign are presented in this paper.