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DETAILED STRUCTURAL DESIGN AND CORRESPONDING MANUFACTURING TECHNIQUES OF THE MASCOT LANDING MODULE FOR THE HAYABUSA-2 MISSION

Abstract

The DLR Mobile Asteroid Surface Scout (MASCOT) is an approx. 11kg shoebox-sized lander platform developed in cooperation with CNES and JAXA for the Hayabusa 2 (HY-2) Asteroid Mission, which was launched successfully in December 2015 to the C-class asteroid 1999JU3. On this mission the MASCOT Landing Module accommodates 4 instruments (camera, magnetometer, spectrometer and radiometer) of 3kg in total. Further it has a mobility mechanism for up righting and hopping, integrated into the common electronic box' housing. The MASCOT structure itself consists of two separate main parts, the Mechanical Electrical Interface Structure (in the following called Interface Structure) and the Landing Module. The Interface Structure is mainly made of unidirectional CFRP (carbon fiber reinforced plastic) struts, forming a highly stiff 680g weighting framework that is fixed in a cutout of one of the HY-2 side panels and encloses the Landing Module. To fixate the Landing Module within the Interface Structure, one central connection bold pulls the Landing Module into four Interface Structure-sided bearings. The focus of this paper is on the only 550g lightweight, cubic Landing Module with its structural (detailed) design and corresponding manufacturing techniques and challenges respectively. In contrast to the Interface Structure, the Landing Module is a CFRP/foam sandwich framework structure. Its architecture is realized in a such way that all interface loads from heavier subunits are only introduced as in-plane loads into one of the sandwich walls. The CFRP/foam sandwich struts have mainly unidirectional face sheets that are locally combined with +/-45deg CFRP fabric plies to account for local stress concentrations. Further the fabrics provide enforcement against shear loads and connect adjacent framework walls to each other. At bearing points the foam core is locally replaced by solid CFRP blocks, which provide sufficient out-of plane stiffness and an enlarged area for out-of plane shear load introduction. One of the six Landing Module's outer sides is closed with a detachable aluminium sandwich radiator that serves at the same time as main integration and late access opening. To interface the radiator structurally and thermally to the other foam sandwich walls a combined solution with and without inserts was applied. Next to these mechanical aspects also cleanliness and contamination control aspects, e.g. how the foam core was protected and handled, are covered. The paper will close with a lessons learned section.