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Space Structures I - Development and Verification (Space Vehicles and Components) (1)

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SPECIAL TESTING AND TEST STRATEGIES FOR UNIQUE SPACE HARDWARE DEVELOPMENTS

Abstract

Hardware developments for new and innovative space applications require extensive testing in order to demonstrate the functionality under the expected environmental conditions. Within several projects the German Aerospace Center (DLR), Institute of Space Systems used its test capabilities for unique tests campaigns that went beyond standard qualification testing.

Several developments in recent years focused on deployable components and corresponding mechanisms. Examples are Solar Sail developments in DLR's Gossamer-1 project, Drag Sail developments in ESA funded projects Deployable Membrane and ADEO, the test of an articulated boom in the ESA project ABDS (Articulated Booms –Large Ultrastable Deployable Structures), separation and deployment tests of the HP3 instrument used on NASA/JPL Mars mission Insight, the MASCOT (Mobile Asteroid Surface Scout) on JAXA's Hayabusa2 spacecraft, and most recently such research and development is continued in DLR's Gossamer Solar Array (GoSolAr) project.

Especially in the development phase but also for life-cycle testing non-standard tests are required for hardware verification in addition to standard qualification tests (vibration, shock and thermal-vacuum). These tests included venting of stowed membranes, deployment under different thermal-vacuum conditions, shaker tests under cryogenic conditions and radiation tests with electromagnetic radiation as well as protons and electrons. Furthermore, a deployment test rig with the possibility of deployment force measurement was built in a clean room ISO 8 environment. In addition, the combination of all test-facilities allows life-cycle tests according to a test-as-you-fly approach. High-fidelity characterization tests for flight operations planning of critical mission phases were performed at the fully integrated system-level for small

spacecraft, including extensive mission environment simulators and multiple-topic instrumentation within one test campaign. Such integrated testing becomes more important as small spacecraft become more and more organically integrated.

For the above mentioned projects and missions different test approaches are described. Test setups, deployment test rigs and other Mechanical and Electrical Ground Support Equipment are shown and the tests as they were carried out are described.

As a result of these test campaigns new technologies were brought to Technology Readiness Level 4 and 5, some are approaching a first flight demonstration and others already proved and still prove themselves in flight, even in interplanetary space. Furthermore, the established know-how and test facilities are being used more and more frequently for unique technology developments.