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PHOEBUS AN ARIANEGROUP & MT-A COOPERATION FOR PREPARATION OF AN OPTIMIZED LIGHTWEIGHT LOW COST FUTURE UPPER STAGE

Abstract

In order to respond to the quick and challenging evolution of the space market demand, continued improvements to the competitiveness of the Ariane 6 launcher are under development. One significant increment for the Ariane 6 upper stage is the exploitation and verification of the use of composite materials and related technologies in particular for the cryogenic propellant tanks and other primary and secondary structures. ArianeGroup and MT Aerospace are combining their expertise to design and test the PHOEBUS ground demonstrator in order to prepare the development of such a composite Upper Stage (Black Upper Stage), enabling a significant performance increase and better access to new missions by reducing the mass and production cost.

The first step on the way to an Upper Stage with an increased share of CFRP materials and technologies is the definition of a suitable architecture. The FLPPneo project MUSE aims at defining such an optimized architecture. From the MUSE project, a reduced set of requirements (reduced to scope of both cryogenic tanks and their connecting structure) is derived for the full scale PHOEBUS target application. However, due to manufacturing capability, budgetary and time constraints such a full scale prototype cannot be realized.

The aim of the PHOEBUS project is to raise the TRL of the key technologies towards TRL 6 via manufacturing, assembly, integration and, finally, test of the demonstrator. Compatibility with liquid oxygen and permeation of liquid hydrogen through the CFRP wall thickness, are at the two major challenges.

The PHOEBUS demonstrator LH2 tank diameter is adapted to a relevant 2/3rd -scale (3.5m vs. 5.4m), whereas the LOX tank is almost full scale (3.5m vs. 3.6m). Other components on PHOEBUS are fully tailored to the demonstrator needs, without any active components on the PHOEBUS test article itself. The planned paper describes the activities and results obtained during the phase A/B of the project:

- Baseline architectural concept evolution.
- Process of material selection and first cryogenic tests of liner-less CFRP tanks with liquid hydrogen and liquid oxygen.
- Implementation of innovative technological concepts concerning tank suspension, tank thermal isolation and local interface concepts.
- Achieved and planed intermediate technology maturation on relevant subscale elements.

The transformation from an aluminium stage to a Black Upper Stage is challenging, but underway to optimize the performance of the next generations of European Launcher systems.