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Title

Advancements in Upper Stage Technologies and Design within ESA's Future Launchers Preparatory Programme (FLPP)

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Abstract

With an almost 1:1 impact on payload capacity, mass reduction in launcher upper stages results in significant improvements in overall performance. Additionally, new technologies that for example enable longer durational operations increase upper stage and launcher versatility. Starting in 2018 work has been ongoing in FLPP on optimised designs for possible evolutions of the Ariane family upper stage. Configuration studies have shown a payload performance gain of over two tonnes for GTO missions is achievable, whilst also reducing the recurring cost of the stage. The work on the upper stage is integrated in approach, working along the FLPP System/Services pull – Demonstrators/Technology push principles.

An upper stage system study – the Multifunctional Upper Stage Express (MUSE) project, linked to launcher system activities carried out in parallel in FLPP – had the initial important task of identifying an upper stage concept, architecture and applicable technologies that would bring significant payload performance gains in future evolutions of Ariane 6. By the end of 2020, an upper stage concept complying to the High-Level Requirements provided by FLPP had been selected, including estimated performance gains and recurring cost reductions and providing outlines of all sub-systems. The selected configuration makes use of the new design possibilities allowed by the application of carbon-fibre reinforced plastic (CFRP) tanks and structures, which are matured in separate FLPP demonstrator and technology projects.

The system-level analysis will continue as work proceeds on future space logistics systems and technology maturation projects – where each technology has been selected for maturation due to the quantified system impact and where all technology maturation results feed into an ever more consolidated upper stage design. The upper stage system will also continue working on the functional simplification of the upper stage including the transfer of versatility to kick-stages, the search for safe and low performance impact de-orbitation manoeuvres and contributing to an overall understanding on future launcher needs i.e. linked to new mission profiles.

All technology areas of the upper stage are matured across various projects within FLPP, all linked to the system analysis, providing the functional requirements for the sub-systems and technologies and permanently evaluating the system-level impact including recurring cost and therefore the interest of the application of the technologies. This paper will present the current status of results from the MUSE project as well as associated technology and demonstrator projects such as the PHOEBUS/COMET/COSTELAS CFRP upper stage structural demonstrators, the large green kick-stage and next-generation avionics, the latest engine demonstrator findings in applying additive manufacturing for the thrust-range of 10 to 100 kN and the FLASH technology maturation project in the structures, functional propulsion system and avionics domains.