SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems Technologies (5)

Author: Mr. Philippe Caisso
Safran Aircraft Engines, France

Mr. Jean-Michel Sannino
Safran Aircraft Engines, France
Mr. Francois Lassoudiere
Safran Aircraft Engines, France
Ms. Elisa Cliquet
Centre National d'Etudes Spatiales (CNES), France
Mr. Eric Louaas
Centre National d'Etudes Spatiales (CNES), France

OVERVIEW OF CRYOGENIC ENGINES STUDIES IN FRANCE FOR MAIN STAGE PROPULSION OF FUTURE LAUNCHERS

Abstract

Several launcher concepts are currently being studied in France, in order to prepare the future of European launchers. Among other concepts, potential evolutions of Ariane 5 and a brand new classical expandable launcher in the range of 5 to 8 tons in Geostationary Transfer Orbit (GTO) are being assessed for the 2025 time frame. A possible evolution of Ariane 5 could consist of replacing Vulcain 2 main stage engine by a new engine with a higher thrust and higher inlet pump mixture ratio, keeping the main stage diameter and height unchanged, but the two tanks volumes should be different than the current one's, and an upper stage equipped with a Vinci engine. Such an evolution could allow to put around 14 to 15 tons in GTO. The new Expandable Launch Vehicle design called ELV 2025, would be a two stage launcher, equipped with a Vinci engine for upper stage and two high thrust cryogenic engines for main stage propulsion. The flexibility from 5 to 8 tons GTO would be achieved through the use of strap-ons. Both launcher options feature a cryogenic main stage which will need a very powerful engine with a thrust equal of higher than 2000 kN, depending on thermodynamic cycle choice. This paper presents several candidate engines, whose preliminary designs are mainly based on new technologies that are currently being demonstrated in Europe, through a dedicated programme named "Vulcain X". Most of these new technologies aim at lower costs, better robustness and performance increase. Three engine designs using part of all these technologies are presented in deeper details : a 2000 kN staged combustion engine (MC2000E) for a future Ariane 5 and its variant for an ELV 2025 in a two-engines configuration, a 2200 kN gas generator engine (MC3000G), used in a two-engines configuration on an ELV 2025, a 2500 kN "building-block" gas generator engine based on the use of two Vulcain 2 thrust chambers. Finally this paper shows the overall step by step approach which is implemented to prepare the future engines required for main stage high thrust cryogenic propulsion : from the demonstration of key technologies at component level to the integration of these technologies into conceptual engines that are currently being assessed for various future laucher architectures.