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LESSONS LEARNT DURING THE DEVELOPMENT OF VEGA LAUNCHER SOLID ROCKET MOTORS

Abstract

VEGA is the new launcher of the European Space Agency (ESA) qualified with the successful maiden flight on last 13rd February from the Centre Spatial Guyanais in French Guyana. Tailored for small payloads and low earth orbit missions, VEGA is a single-body four-staged launcher with three solid propellant rockets and one liquid propulsion upper module, which today completes the family of the European launchers, beside Ariane5 and Soyuz. VEGA three SRMs, the first stage P80 (Europropulsion/Avio), the second Zefiro23 (Avio) and the third Zefiro9 (Avio) share the same finocyl configuration, characteristics and technologies, but have different sizes and performance.

This paper wants to discuss and summarize the main activities performed during about the last ten years for the development of the VEGA launcher SRMs from this workgroup at Sapienza University of Rome, with the supervision of the ESA VEGA Integrated Project Team. In particular, the attention will be focused upon all the "lessons learnt" during the VEGA solid stages development: from Zefiro16, prototype of the Zefiros family SRM to Zefiro9A, "last born" of the Zefiros family and flight version of the third stage. The activities spanned all the relevant aspects in SRMs internal ballistics, from the SRM ignition to burn-out.

Firstly, the use of the helium as pressurizing gas for all the SRMs, chosen in order to reduce the pressure oscillations during the ignition transient to which Zefiros family SRMs are prone, will be discussed from both "historically", during the project evolution, and technical point of views, from Zefiro16 to P80 (DM fired with helium and QM with nitrogen).

Afterwards, the analyses performed during the design of Zefiro9A will be described, analysing the reasons behind the subsequent modifications of Zefiro9A with respect to the Zefiro9 configuration, focusing the attention on the phenomena occurring during the first phase of the ignition transient.

The description of the contributions of this workgroup to VEGA development will be then centred on the prediction and reconstruction methods and their results of all the VEGA static firing tests, through different kind of analyses: 0D post-static firing tests reconstruction, Q1D simulation of the internal ballistics and reconstruction of the P80 pressure oscillations.

All these activities have been performed with a series of numerical and analysis tools developed "in-house" at Sapienza University of Rome - DIMA Propulsion Area, that are at the state of the art of the simulation models applied to Solid Rocket Motors.