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Author: Dr. Enrico Cavallini
Sapienza Università di Roma, Italy

Prof. Bernardo Favini
Sapienza Università di Roma, Italy
Prof. Maurizio Di Giacinto
Sapienza University of Rome, Italy
Dr. Ferruccio Serraglia
European Space Agency (ESA), Italy

ZEFIRO 9A STATIC FIRING TESTS: AN INVESTIGATION ON DATA DISPERSIONS

Abstract

This paper wants to present and discuss the reconstruction of three Static Firing Tests (SFTs) of the VEGA Launcher third stage Solid Rocket Motor (SRM), Zefiro 9A (Z9A).

VEGA is the new launcher of the European Space Agency, whose first flight is foreseen in the next months. 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. The three SRMs, the first stage P80 (Europropulsion), the second Zefiro 23 (Avio Group) and the third Zefiro 9 (Avio Group) share the same finocyl configuration, characteristics and technologies.

For Z9A, VEGA third stage (evolution of the Z9 SRM), the Head End Pressure (HEP) and thrust experimental data coming from three different static firing tests (QM2, VT1 and VT2) will be analyzed with the use of a quasi-one dimensional (Q1D) model SPINBALL, able to simulate the complete SRM operational time, from ignition to burn-out. The analysis will be completed with the reconstructions of the data coming from the experimental testing for propellant characterizations and of the experimental data from the SFTs, performed with a zero dimensional (0D) quasi-steady model.

The three Z9A SFTs experimental measures have registered some differences in time histories of both the HEP and thrust during an advanced phase of the quasi-steady state, suggesting some differences in the SRM internal ballistics. As a matter of fact, these different SFTs outcomes have not found any explanation based on the small differences however existing among the three Z9A, as, for instance, nozzles throat diameter or propellant casting etc..

The purpose of this work is therefore to perform a reconstruction of the different SRM behaviors for the three SFTs, trying to analyze and find out the root cause from a propulsive point of view. The study will hence consider: firstly a revision and analysis of the propellant batches characterization made before the grain propellant casting of each SFT, through the BARIA experimental set-up, then a reconstruction of the SFTs will be provided with the use of the 0D internal ballistics reconstruction model, using the SFTs experimental data, and finally the SRM internal ballistics for the SFTs will be simulated with the use of the Q1D SPINBALL model.