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ELECTRO-MECHANICAL THRUST VECTOR CONTROL SYSTEMS FOR THE VEGA-C LAUNCHER.

Abstract

Electrical thrust vector control systems have replaced nowadays hydraulic actuators in unmanned flight-critical applications: faster assembly, easier installation and utilization and lower maintenance constraints are some of the benefits of the electrical system.

SABCA has designed electrical Thrust Vector Control (TVC systems for the VEGA-C launcher stages based on the experience and taking into account the lessons learned of the VEGA TVCs in operation since the first VEGA flight in February 2012. The aim of the TVC is to control the flight of the launcher by mastering the direction of thrust. It is a nested loop (small loop) inside the launcher attitude control. The direction of the thrust is mastered by steering the nozzle deflection angle.

The paper will present the main drivers and lessons learned introduced in the design of this new generation of TVC systems. These will be illustrated by some design implementations. First test results of this system in laboratory environment at SABCA (Belgium) will be presented as well as results obtained during the engineering and qualification static ground firing tests performed in Kourou (French Guyana) and Sardinia (Italy).

Vega-C is based on the existing Vega launcher and comprises four stages. Three stages will use solid-propellant motors and one will use liquid propellants. The first stage is based on the P120C, the largest monolithic carbon fibre solid-propellant rocket motor ever built. Its development relies on new technologies derived from those of P80, Vega's current first stage motor. The P120C will also be used for the liftoff boosters on Ariane 6. The second stage with the new Zefiro-40 (Z40) motor will contain about 36 tons of solid propellant providing an average thrust of 1100 kN. The Zefiro-9 third stage corresponds to the currently stage used on Vega, no modification of the TVC system have been applied for VEGA-C. The AVUM+ upper stage for orbital positioning and attitude control is derived from the current Vega AVUM but has a lighter structure. It carries more propellant inside larger tanks however the TVC system remains as it is on the VEGA launcher.

The main objectives for VEGA-C launcher - and thus also for the TVC systems - are to increase performances, reduce operating costs and provide cost-efficient launch services. The paper will also present how this is achieved for the TVC systems.