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Quality and safety, a challenge for traditional and new space (1)

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MATRIOCHKA SPACE PROJECT D5.1

Abstract

Matriochka is a two-stage experimental rocket built by a student team from ESTACA, a leading French school in aerospace engineering. The project aims to launch a reusable launcher to send small rockets as payloads. In other terms we speak about "a rocket in a rocket" which implies new architecture requirements for the launch vehicle. The reusable first stage of Matriochka is recovered by a parachute. The higher part of this stage hold the payload which imposes flexibility. Moreover, the payload separation is reached by propulsion sub-system which is called the "Heat Jettisoning". Flight and ground safeguard is the top priority for operations and launch. We handled safety by promoting simplicity at each step that is why the "Heat Jettisoning" solution was chosen. A single system actuate two different operations: the payload engine ignition permits the second stage separation. Simplicity made us practicing well-known technologies with high TRL as well as a step-by-step validation. This approach was enforced by dependability analysis and thermal studies on jettisoning system. Safety rules are demanding. French experimental rockets are usually made for a single flight making Matriochka a kind of pioneer. Moreover the two-stage rocket launches are unusual, which make the controls demanding to prevent any anomalies and ensure safety.

That is why the electronics design has been a critical part of the project. It has two main roles: to ensure the separation of the second stage and to protect the pyro-technicians and the public from an inadvertent ignition. Safety barriers have been implemented to avoid the second stage ignition before the rocket take off. The parameters take into account the orientation of the launcher to ensure the separation in the opposite direction of the public. The mechanical architecture is also made to maximize the safety, thus the launcher contains a guide for the second stage which made it a kind of a "flying launch ramp". Because of the safety criticality, most of the flight tests before launch were focused on the electronics. The final test consists on a "Hardware-In-The-Loop" simulation to validate the behaviour of the rocket in the more realistic conditions. Matriochka had a successful flight in France on the 23/07/2017. For us, students, this has been one of the best experience of our life!