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FROG, A ROCKET FOR GNC DEMONSTRATIONS

**Abstract**

Reusability in the launcher sector has been studied for quite a long time in Europe, but so far, projects have mostly stayed on the drawing-board. Today, players from the so-called “NewSpace” demonstrate rocket boosters’ recovery and reusability on a regular basis. The established western rocketry industry is being challenged by new space actors and emerging space nations. In this climate of intensifying competition, there is a growing sense of urgency in Europe, a feeling that we need to seize the moment and change our ways, to prove that Europe still possesses the ability to surpass itself.

The French Space Agency (CNES) is one of the stakeholders in Europe for future launchers preparation, along with ESA, other national agencies and industry. To catch up as quickly as possible, CNES promotes several initiatives at different scales, whether it be with students, academics, SMEs or big players, aiming at fostering key competencies for reusability in Europe. Among these studies, FROG corresponds to the early sandbox approach. It is a low-cost, sub-scale flying testbed which demonstrates guidance and control algorithms for vertical landing. As a matter of fact, among the required technologies for reusable rockets, GNC for landing is deemed to be one of the most challenging ones. This must not be studied only by simulation, but also with tests on demonstrators.

First we will present our early trade-off for FROG concepts, then describe the common platform which is currently in development (structure, landing gear, avionics), and finally delve into the GNC aspects. We intend to fly two versions of FROG, the first one in 2018 equipped with a small modelism turbojet, and the next one with a monopropellant rocket engine, which is more challenging (but also offers a better representativeness), and needs further detailed design. For the development of GNC, it has been chosen to work on the control and guidance systems, by using Matlab/Simulink models for the optimization and

validation of the parameters, but also by early tests with a very small subscale platform which brings out what cannot be simulated. For both FROG versions, the test plan begins with several captive test flights, then the degrees of freedom are progressively released to end up with free flight validation tests.