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Development and Flight Testing of a Distributed Electric Propulsion Demonstrator

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The AeroSwitch concept combines a distributed electric propulsion (DEP) configuration with a set of propulsive control logics allowing the in-flight simulation of either a single-engine or a twin-engine airplane. This was initially motivated by the will of providing a flying school with a single platform capable of supporting training for both single-engine and multi-engine pilot rating. The concept was developed in a full preliminary design, leading to the Trybrid General Aviation aircraft, which was awarded the 1st place in the annual AIAA Graduate Student Aircraft Design Competition. To provide a complete demonstration of the practical feasibility of such a disruptive concept, a scaled radio-controlled model was developed to be fully representative of the Trybrid. This model, named SwitchMaster, employs a set of three thrust units, each composed by an electric motor and a fixed-pitch propeller, placed at the leading edge of each wing. The SwitchMaster was extensively tested on ground and in flight, fully demonstrating the effectiveness of the AeroSwitch concept in both its normal and failure modes. Furthermore, the flying model represents a fitting testbed to study the aeropropulsive coupling inherent to the DEP and develop innovative applications in the field of propulsion-controlled aircraft (PCA) such as trajectory steering, attitude control and stability, high-lift augmentation.

Current activities are aimed at providing a fundamental enabler for the above-mentioned studies, *i.e.* an accurate flight dynamics model. Indeed, predicting the effect of extensive wing blowing on the aircraft's flying qualities is difficult and flight data are not easily matched based on traditional methods. Particularly, the lateral-directional dynamic behavior appears elusory. Therefore, a second flight test campaign is currently ongoing, dedicated to model identification for the full longitudinal and lateral-directional dynamics. This aims at identifying the aerodynamics of the complete aircraft, including an adequate model of the impact of DEP on the aerodynamic characteristics. Preliminary results show a promising behavior of the numerical model (an example is given in Figure 1) in capturing actual flight data.

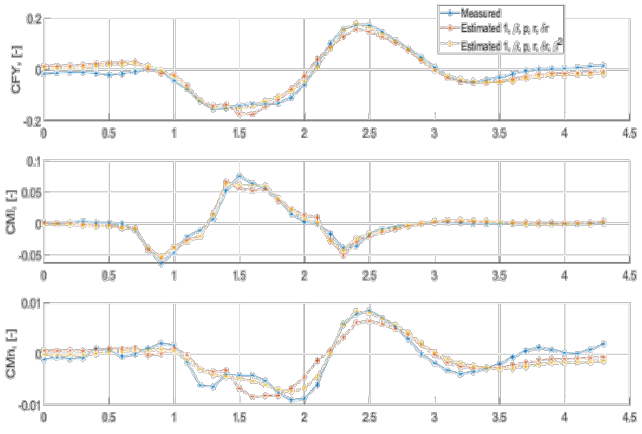

Figure1: Lateral-directional coefficients in a bank-to-bank (blue: measured; red and yellow: estimated)