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GUDGET: GUST GENERATORS AND MODEL DESIGN FOR TRANSONIC WIND TUNNEL TESTS

PROJECT OBJECTIVES

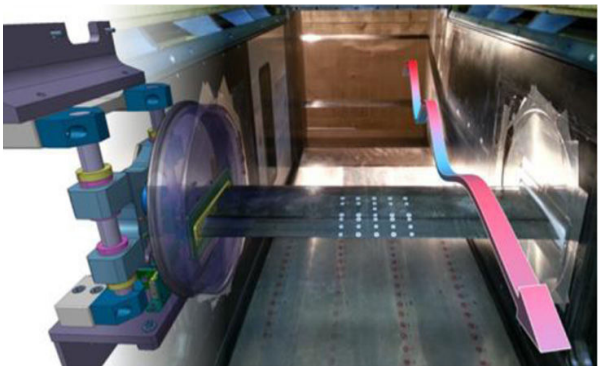

Fig. 1: Overview of the wing airflow into a wind tunnel

The **GUDGET project** will design, manufacture, calibrate, verify and finally install in the ONERA S3Ch **Wind Tunnel** (WT) an enhanced **gust generator** system and an aeroelastic half-model connected to the WT side wall, with the purpose to support **ONERA** in the execution of a **WT test campaign** and gather information on the aeroelastic behaviour of the model under **high amplitude gust conditions**, with the acquisition of a relevant database will allow to assess the numerical capabilities for the prediction of gust loads. At this aim, the consortium GUDGET has, first of all, to **perform the design** of the experimental setup. This means to design and manufacture the WT model according to technical requirements provided by ONERA. Special care will be dedicated to the **dynamic characteristics** of the final model, by ensuring that at least the three first normal modes will be in the frequency bandwidth **[0-100 Hz]**, and that a specific interface with the WT will be implemented, with an elastic constraint around the model pitch axis.

In parallel, the consortium GUDGET will perform a preliminary **trade-off analysis** to find the best configuration of the GG to comply with requirements dictated in the topic, by considering innovative configurations of tilting airfoils moved by mechanical actuators as well as **blowing slots** fed by fluidic actuators or a combination of both. The objective is to develop **8 PJA** that can provide a **sonic jet** and with a **mass flow of 32 g/s** for each one. The upstream pressure is 10 bar whereas the downstream pressure is close to 1 bar.

INNOVATION

Previous projects have already studied and designed **AFC solutions**. We can mention VIPER which focused on the development of a Pulsed Jet Actuator (PJA), an actuator with non-zero mass net flux, and ASPIC or SynJet3C, whose target was a Synthetic Jet Actuator (SJA) based on Amplified Piezo Actuators (APA®) of large dimensions.

Mechanism developed on VIPER was only a laboratory prototype to demonstrate the working of a PJA with APA® technology. The additional constraint on GUDGET project is to develop a **miniaturized PJA** that can be implemented into a wing for allowing high level test with the ONERA wind tunnel. One difficult constraint is to design a **high performance PJA** with mechanical space limitations.

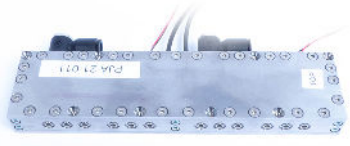

Fig. 2: Overview of the final version of PJA for GUDGET project

The developed PJA is built with two APA (Amplified Piezo Actuator), working as valves. Moreover, to check the well operating of the system, two dedicated magnetic position sensors were integrated into the PJA. A specific external conditioner SA75B was also developed to read the displacement signal.

The required performances were validated by several test campaigns.

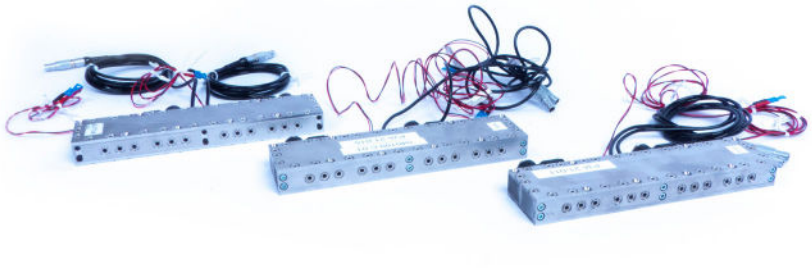

Fig. 3: Overview of 3 PJA after mounting and testing, ready to be implemented into the wind tunnel

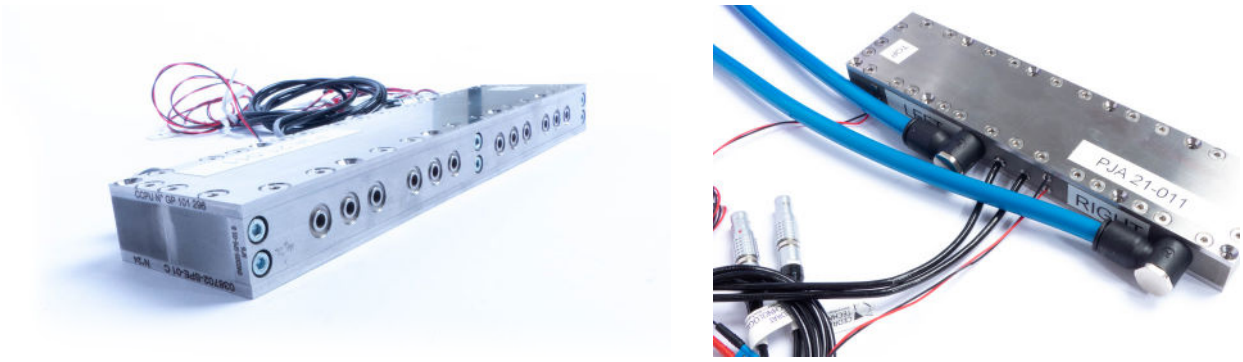

Fig. 4: Front and Back views of the PJA

In addition, the development of a non-standard APA was needed to reach the requirement targeted to drive a dynamic aileron. This new APA is able to reach a free stroke of 680 µm and a blocked force of 310 N, in a limited space.

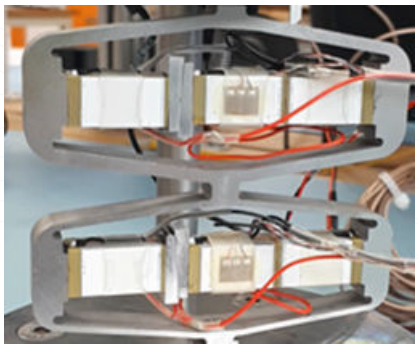

Fig. 5: Overview of the aileron actuator

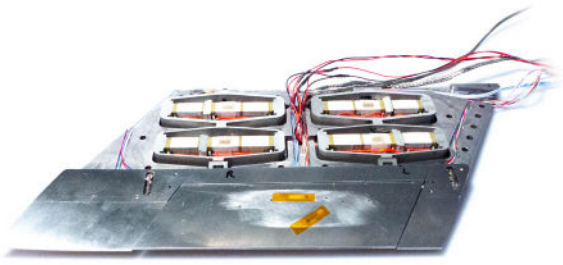

Fig. 6: Overview of the two aileron piezo actuators, integrated into the wing

Watch the aileron's actuation video: https://www.youtube.com/watch?v=bCJ_usBgx5I

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CTEC CONTRIBUTION IN THE PROJECT

In the GUDGET project CTEC oversees:

- Design of a **new miniaturized PJA prototype** following requirements needed for aircraft wing integration,
- Manufacturing and **tests** of the prototype to validate the predicted performances,
- Optimize the prototype and **produce some eight PJA** for integration in the wing model into the wind tunnel,
- Produce the associated **drive electronics**.

CTEC will use **heritage** from the former **VIPER** projects using PJA, also developed for aircraft application. The general principle of such a flow control actuator is to inject a **high-speed pulsed air flow** on the air foil surface, through slots or holes. The interaction of this secondary flow aims at improving the aerodynamic performance of the aircraft.

PARTNERS

- ONERA : Topic Manager
- IBK Innovation : Coordinator
- CEDRAT TECHNOLOGIES
- Aviation Design
- Politecnico Di Milano
- Dream Innovation

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