PROPOSITION DE STAGE – MASTER 2 DET

Dynamique des fluides, Energétique et transferts

Université Toulouse 3 Paul Sabatier - Toulouse INP - INSA Toulouse - ISAE SUPAERO – IMT Mines Albi

Titre : Numerical study of the effect of inlet distortions on a ducted propeller

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Lieu du stage : ISAE -Supaero
Durée / période : 5-6 mois entre février et septembre 2023
Candidature : CV, lettre de motivation, références à envoyer à Sébastien Duplaa

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Sujet

The ongoing ecological crisis imposes a renewal of the aeronautical industry. The need for improved efficiency for aircraft is at the core of the research and many innovative solutions are proposed and distributed propulsion is one of these potential answers. The idea is to use many small propulsors instead of a few big ones. Indeed, electrical motor's weight scales with the torque delivered. To minimize weight, small propulsor with a small load and high rotational speed are proposed.

Figure 1: ONERA DRAGON

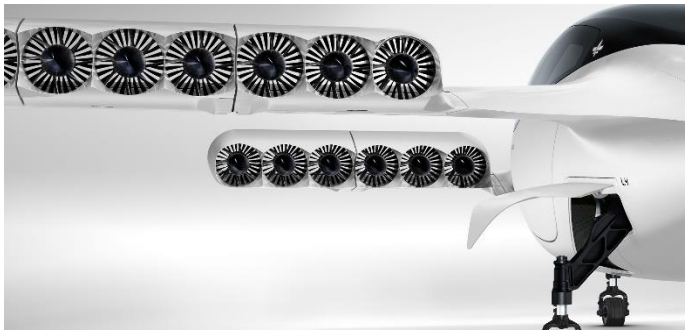

Figure 2: Lilium Aircraft

In the case of aircrafts flying at slow enough speed, the nacelle containing the motor and rotor can be designed in such a way that it increases the efficiency and the thrust of the propulsor compared to a free propeller (Kort nozzle). As such, the propulsive system is comprised of both the rotor and the nacelle; and their mutual interactions are not negligible.

Another synergy possible with distributed propulsion is the use of Boundary Layer Ingestion (BLI). The benefits come from two sources:

- A reduction of the viscous drag by ingesting the low-speed air in the boundary layer
- An increase in the propulsive efficiency of the rotor by reducing the exit velocity of the jet

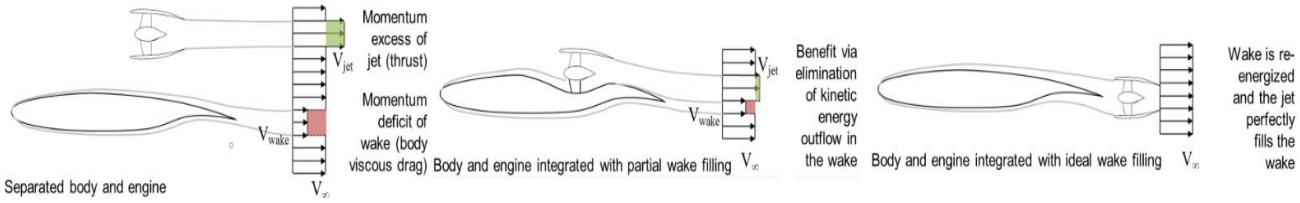

Figure 3: Principle of the Boundary Layer Ingestion

However, while a boundary layer is a few centimeters thick at most, the diameter of the propulsor is around forty centimeters. The rotor will then periodically enter and exit the boundary layer, changing the velocity triangle on the blades and cancelling the axisymmetric hypothesis. The impact on the nacelle will also be important as a non-uniform flow can create parasitic effect and forces or in the contrary, filter some of the distortion.

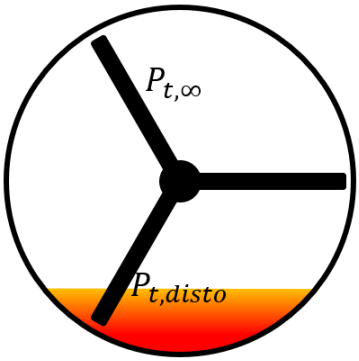

Figure 4: Type of distortion when using BLI

PropHyDis test bench is a ducted propeller with complete instrumentation to measure the performances of the experimental device. It will be put in a wind tunnel with distortions grids in order to reproduce conditions similar to a boundary layer ingestion.

The objective of this SFE is to use CFD simulations in order to simulate the response of the propulsor with different distortions. The results from these simulations will help create a way of modelling the behavior of PropHyDis and better understand the physic of distortions.

Figure 5: PropHyDis, experimental ducted propeller in the SaBRe wind tunnel

The candidate will mainly use StarCCM+ as the CFD solver and be helping on an ongoing thesis at the department. It is expected that the candidate has good notions on turbomachinery, fluid mechanics and CFD. The candidate shall be able to work independently and be able to propose solutions when difficulties arise.