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THE FRENCH AEROSPACE LAB

POST-DOCTORATE PROPOSAL

Title: Data assimilation techniques for the qualification of the ONERA vertical wind tunnel in presence of acoustic dampers

Reference: **PDOC-DAAA-2022-05**
(to be recalled in all correspondence)

Start of contract: 1/01/2023	**Application deadline:** 5/12/2022

Duration: 12 months, Net yearly salary: about 25 k€ (medical insurance included)

Keywords

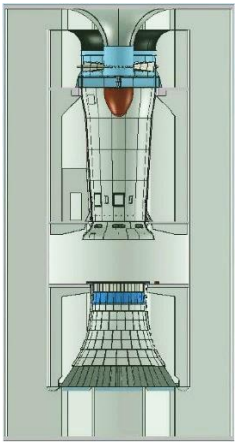
ACOUSTIC, DATA ASSIMILATION, FLOW MEASUREMENT

Profile and skills required

PhD with a previous experience in data assimilation method, acoustic and/or LDV flow measurement

Presentation of the post-doctoral project, context and objective

ONERA is developing new experimental means to accompany the swift development of new aerial vehicles devoted to urban aerial mobility (UAM) and drones which are expected to become ubiquitous in our everyday lives. Those vehicles are equipped with propeller(s) and are intended to operate at low level above densely populated areas. This raise both the issues of acoustic nuisances and safety. The ONERA vertical wind tunnel (see image below) has been recently equipped with acoustic absorbent panels surrounding the open test section. This modification is a prerequisite to the addition of a propeller bench which is currently under study, the ultimate goal being the characterization of acoustic emission of drone and UAM vehicles propellers.



SV4 ONERA center of Lille vertical wind tunnel

The qualification of the wind tunnel without acoustic panel has already been partially performed. Here, the word “qualification” has to be understood as measurements to quantify the flow homogeneity, turbulence level, deviation and longitudinal evolution when the wind tunnel is empty (without model). The general purpose of this postdoctoral position is the qualification of the testing section with the acoustic panels taking also into account a recent modification of the wind tunnel intended to avoid vibrations at the very end of the convergent section. The qualification will mostly rely on a Laser Doppler Velocimetry bench available in the wind tunnel and comparison with the original dataset (without modification devoted to acoustic measurements) is also part the expected outcome of the study.

Recognizing the fact that qualification of such a volume (the test section diameter is 3.9 m) with punctual measurements at high resolution may be very time consuming, it is proposed to develop a qualification strategy relying on the recent developments of data assimilation techniques. The later are capable to enforce a computation (of RANS-type for example) to equal the measurement data at their locations. This approach is then capable of producing of computational solution of the whole wind tunnel at high spatial resolution which is “compatible” with the much scarcer measurement database. The previous internship study of F. Kissel has already demonstrated the possibility to obtain RANS solutions of the SV4 flow which are reasonably accurate in particular in the shear layers on the edges of the jet traversing the test section. This work has to be continued to account for the acoustic panel presence in the wind tunnel and to implement the data assimilation technique. The latter will be based on the nudging approach which is currently been developed at ONERA [1,2]. It consists in introducing in the simulation a term proportional to the gap between the measurement and the numerical estimation to bridge this gap.

This postdoctoral position represents a unique opportunity to address different part of modern fluid dynamics: advanced flow measurement, acoustic, data assimilation in the framework of a large wind tunnel.

[1] Zauner, Mons, Marquet and Leclaire, Nudging-based data assimilation of the turbulent flow around a square cylinder, J. Fluid Mech 937, A38, 2022

[2] Marquet, Mons, Zauner and Leclaire, Turbulent mean flow estimation with state observer assimilation of velocity measurements in RANS models, TSFP12, 2022

External collaborations

Host laboratory at ONERA

Department : Aerodynamics, aeroelasticity, acoustics department

Location (ONERA centre): Lille

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