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THE FRENCH AEROSPACE LAB

PROPOSITION DE STAGE EN COURS D'ETUDES

Référence : **DAAA-2024-41**
(à rappeler dans toute correspondance)

Lieu : Centre de Meudon

Département/Dir./Serv. : Département d'Aérodynamique Aéroélasticité Acoustique

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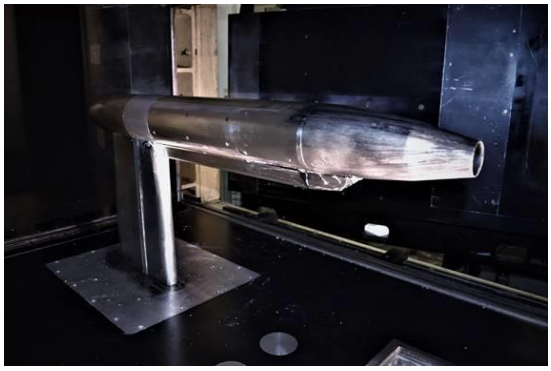
DESCRIPTION DU STAGE

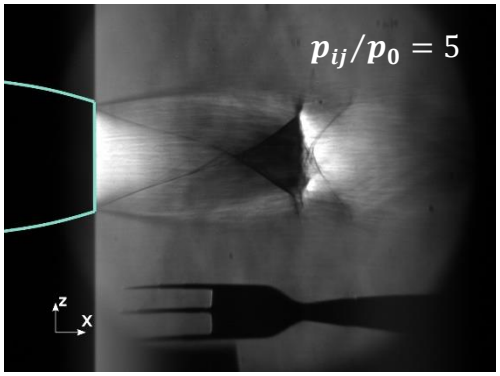
Thématique(s) : Exploitation de données expérimentales et numériques

Type de stage : ☐ Fin d'études bac+5 ☒ Master 2 ☐ Bac+2 à bac+4 ☐ Autres

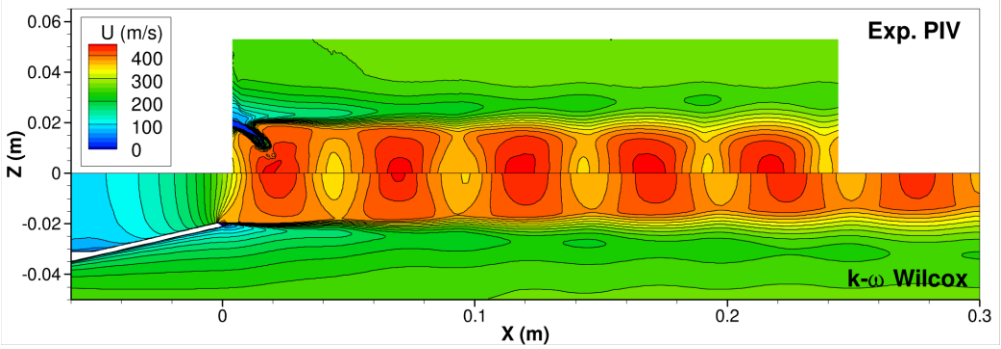
Intitulé : Data-assimilation implementation for CFD optimization procedures in compressible regime

Sujet : Data assimilation for inverse or optimization problems prove to be one of the most successful techniques to date for tuning parameters that influence the solution of engineering models and, therefore, for systems in aerospace. At the S3Ch transonic wind tunnel (ONERA, Meudon), the flow of a propulsive jet was measured via Particle Image Velocitmetry (PIV) technique.





The ratio between the pressure inside and outside the structure simulating the reactor has values between 3 and 5 with a Mach number of 0.8. Consequently, several velocity shock waves can be appreciated from outside the reactor. In the compressible and turbulent regime, the interest is to exploit the data from this measurement to calibrate and possibly choose the appropriate model that describes the phenomenon. To date, as visible from the figure below, RANS turbulent models of the k-ω type show inconsistencies in velocity gradient. Thus, a different choice of model is to be made.



What is explained illustrates the interest in this internship and gives the motivations. The main axis of research concerns data assimilation for optimization procedures in the compressible flow regime. In particular, through the open-source CFD code BROADCAST [1], the student is asked to implement in it an optimization method from numerical or measured data.

In the context of optimization procedures, the objective of the stage addresses to implement in the BROADCAST code a data-assimilation procedure, based on a variational approach, consisting in a correcting a given baseline model by tuning space-dependent source terms such that the corresponding solution matches available measurements (obtained from direct numerical simulations provided by BROADCAST code itself). In particular, the implementation is inspired by the work by Franceschini, Sipp & Marquet [2]. In the original paper, the method was presented for turbulence model in incompressible regime. The technique can be extended to general hyperbolic equations in the compressible regime.

An initial test case of interest in this context is the search for optimal incidence angle for a NACA-type wing in the way of detecting a given measured aerodynamic quantity.

References:

[1] Poulain, A., Content, C., Sipp, D., Rigas, G., & Garnier, E. (2023). BROADCAST: a higher-order compressible CFD toolbox for stability and sensitivity using Algorithmic Differentiation. Computer Physics Communications, 283, 108557.

[2] Franceschini, L., Sipp, D., & Marquet, O. (2020). Mean-flow data assimilation based on minimal correction of turbolence models: Application to turbolent high Reynolds number backward-facing step. Physical Review Fluids, 5(9), 094603.

Méthodes à mettre en oeuvre :

☐ Recherche théorique	☐ Travail de synthèse
☐ Recherche appliquée	☐ Travail de documentation
☐ Recherche expérimentale	☐ Participation à une réalisation

Possibilité de prolongation en thèse : **A renseigner**

Durée du stage : Minimum : 4 mois Maximum : 5 mois (sauf dérogation)

Période souhaitée : 5 mois

PROFIL DU STAGIAIRE

Connaissances et niveau requis :	Ecoles ou établissements souhaités :
Master 2	Université scientifique ou école d'ingénieur