CERFACS

JOB OFFER – STAGE

Characterization of under resolved shear-induced pressure oscillations in the high order method framework

OFFER INFORMATION

Reference: AAM-2024-AC-02
Team: AAM

Location: 42 Avenue Gaspard Coriolis – 31057 Toulouse

Supervisors :

- Arthur Colombié, colombie@cerfacs.fr
- Thomas Marchal, marchal@cerfacs.fr

Gratification : 700€ net per month - M2 level or last year at engineering school
Period : 6 months – from Février 2025 (adaptative)

Mots-clés : Turbomachine, CFD, Analogie acoustique

CERFACS

CERFACS is a private research, development, transfer and training center for modeling, simulation and high-performance computing. CERFACS designs, develops and proposes innovative software methods and solutions to meet the needs of its partners in the aeronautics, space, climate, environment and energy sectors. CERFACS trains students, researchers and engineers in simulation and high-performance computing.
CERFACS works closely with its seven partners: Airbus, Cnes, EDF, Météo France, Onera, Safran et TotalEnergies.

HOSTING TEAM - AAM

The Advanced Aerodynamic & Multiphysics (AAM) team is dedicated to developing cutting-edge numerical methods, physical modeling, and High-Performance Computing (HPC) techniques for new Computational Fluid Dynamics (CFD) solvers. The work focuses on fluid dynamics simulations for aircraft, rockets, and turbomachinery, in close collaboration with CERFACS partners.

CONTEXT

Numerical simulation is of primary importance in the process of design and optimization of industrial systems. It allows access to information that cannot be obtain experimentally, for reasons of geometric complexity, measurement difficulties or simply the high cost of testing resources. Even if most of the industrial numerical simulations are based on steady-state algorithms, some physical phenomena need for unsteady calculations to capture the overall physics at play. In this respect, CERFACS in involved in unsteady solver developments based on several numerical methods. Among others, the JAGUAR solver is dedicated to high order resolution of Navier-Stokes equations, based on the Spectral Difference method (SD). Just like other spectral method (Discontinuous Galerkin - DG, Flux Reconstruction - FR), SD offers to the user an easy way to choose the order of accuracy of the scheme. This property is of prime interest when dealing with fine-grained physics such as acoustics for example. JAGUAR solver is

mainly dedicated to Large Eddy Simulations (LES) and many past and current studies have shown a good level of maturity for aerodynamics and combustion applications.

Nevertheless, recent work to reach Direct Numerical Simulation accuracy has highlighted an unsuspected behavior of the high order methods. Indeed, when subjected to unresolved shear, these methods induced pressure oscillations that affects measurements of acoustics and high order turbulent statistics. Mechanisms at play are little known and the condition in which the phenomenon appears remain to determine. This internship is part of this and aims at characterizing the oscillations more precisely.

MISSION

The purpose of the internship is first to characterize the pressure oscillations appearing when the sheared flow is under-resolved. The first step consists in comparing the results obtained by several numerical methods to quantify the amplitudes of the oscillations. Preliminary studies had been led by a former intern and the present assignment aims to extend this previous work while deriving equivalence between the methods tested in terms of shear resolution, for a given accuracy on the pressure. In this context, the intern will have to develop 1D numerical prototypes (python language) and to use in-house numerical solvers for 2D and 3D computations. A second step consists in the better understanding of the phenomenon that leads to the oscillations. Current studies would suggest a strong coupling between the interpolation step and the resolution of Riemann's problem at the interface of spectral elements. The intern will have to understand the numerical method to take part in these works. The aim is to highlight the numerical steps that trigger the phenomenon. At the end of the internship, and based on the progress made, several solutions might be developed and tested in order to reduce the oscillation to an acceptable level for DNS applications.

DESIRED PROFILE

- Currently in the final year of an engineering degree or equivalent, specializing in fluid mechanics.
- Strong experience in computational fluid dynamics (CFD) programming is required.
- In particular, skills in numerical method programming is an advantage.
- As this is a research-oriented internship, the candidate, who is preparing for a Research Master's degree, will be required to present his/her work both orally and in writing in English, in line with the standards expected in an international research laboratory.

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- A structure accessible to people with disabilities.
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- 50% reimbursement of public transport costs.

HOW TO APPLY ?

To apply, please send your CV and cover letter to colombie@cerfacs.fr , applications are open until 20/12 of the current year.

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