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POST-DOC PROPOSAL - Fixed-term contract

Analysis of the jet dynamics of a multi-engine reusable rocket

Reference: CFD-2024-DAV-04
Team: CFD
Research unit: Advanced Aerodynamics and Multi-Physics
Employer: CNES (contact Simon.Blanchard@cnes.fr)
Starting date: September 2024

Location: 42 avenue Gaspard Coriolis – 31057 Toulouse
Contact person: Guillaume Daviller
E-mail: daviller@cerfacs.fr
Duration: 2 years
Level of education required: PhD

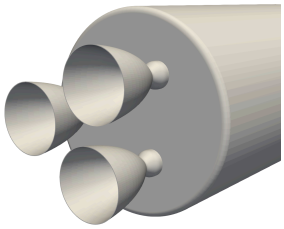
https://recrutement.cnes.fr/en/annonce/2746127-24-211pd-analysis-of-the-jet-dynamics-of-a-multi-engine-reusable-rocket-31100-toulouse

HOST LABORATORY

The **Cerfacs** is a fundamental and applied research center specializing in modeling and digital simulation. Through its resources and expertise in high-performance computing, it addresses major scientific and technical problems in public and industrial research. The Cerfacs teams develop innovative methods and software solutions to meet the needs of the aeronautics, space, climate, energy, and environment sectors. Cerfacs works in close interaction with its seven associates: **Airbus**, **Cnes**, **EDF**, **Météo France**, **Onera**, **Safran**, and **TotalEnergies**.

HOSTING TEAM

The CFD (Computational Fluid Dynamics) team is the largest team at CERFACS. It focuses on the simulation of flows by developing advanced numerical methods and applying them to aircraft, rockets, helicopters, car engines, turbines, etc. This team develops essential tools in many application fields with a well-known leitmotiv in the industry today: let's calculate systems (aircraft, engines, etc.) before building them.



JOB DESCRIPTION

Topic(s): Aerodynamics Acoustics Combustion High Performance Computing

Context: Improving the propulsive performance of rocket engines is a major challenge in today's competitive environment, when it comes to launching low-cost payloads. Furthermore, several future European launchers will use a multi-engine aft bay. This post-doctoral study aims to investigate the dynamics of the jets emanating from the nozzles of these engines and their interactions during the ignition/extinction phases. Indeed, the physical mechanisms that generate aerodynamic instabilities in the rocket engine nozzle (side-loads, flow separation...) associated with intense acoustic radiation are still poorly understood. In addition, the important heat load is a problem that has a significant impact on the design of rocket engine nozzles [1]. Finally, the instabilities encountered in over-expanded nozzles at the nominal operating point, after ignition, which generate strong acoustic radiation, also need to be understood to be controlled. In this context, CNES is working with CERFACS as part of the Aérodynamique des Tuyères et Arrière-Corps (ATAC) research group.

Mission: The objective of this work is to use numerical simulations to characterize the instabilities of supersonic flows at the outlet of three engines. Indeed, it has been demonstrated that large-eddy simulations (LES) can be used to predict these particularly unsteady phenomena [2]. Identifying the physical phenomena behind the instabilities will thus contribute to a better understanding of the interactions and couplings between the various phenomena that induce self-sustained acoustic oscillations. Finally, the thermal impact of flows on nozzle divergent will also be taken into account. For this numerical study, the CERFACS AVBP code will be used for simulations, and the Antares library for post-processing [3].

[1] S. Blanchard et *al.,* Acta Astronautica, 2022.
[2] G. Daviller et *al.,* Int. J. Comp. Fluid Dyn., 2020.
[3] Antares documentation release 2.0.0, https://www.cerfacs.fr/antares

DESIRED PROFILE

Background required: Numerical simulation Fluid dynamics Fortran & Python Languages: French or English

Abilities:Capacity for analysis and synthesis Innovation capacity Ability to work independently Relational qualities Rigorous

PLEASE SEND CV + COVER LETTER