POST-DOC/RESEARCH ASSISTANT

Keywords: aerodynamic shape optimisation, body-force modelling, variable geometry

Department: Aerodynamics Energetics and Propulsion Department (DAEP)

Design and Off-Design Analysis of Ultra-Short, Adaptive Nacelle for Ultra-High-Bypass Ratio Turbofans.

JOB DESCRIPTION:

Ultra-short and thin nacelles are a well-known solution to compensate the weight and drag penalties related to an increased fan diameter. In particular, the reduced wet surface of a short nacelle reduces friction drag at cruise. However, short nacelles are subject to flow separation in off-design conditions (especially take-off), which creates distortion and severely penalizes the fan efficiency. Peters et al. [1] have shown that inlets with a length-to-diameter ratio L/D below 0.25 are not robust without the use of an additional feature such as variable-geometry. In this context, we have proposed a slotted-inlet variable geometry concept as a potential enabler for nacelles with length-to-diameter ratios lower than 0.25. Through RANS numerical simulations, we showed that the slotted inlet could alleviate flow separation observed under incidence conditions on a very short L/D=0.19 nacelle. We also observed that there could be a potential for passive actuation since the steep flow turning around the nacelle lips that led to flow separation also causes forward-pulling forces on the slot.

In order to simulate the strong fan-inlet interactions and the fan performance under distortion, we propose to model the fan stages by using a body force approach. This principle, not new in turbomachinery, has been used to deal with short nacelles [2], cross-wind conditions [3] or aero-

[1] Andreas Peters, Zoltán S Spakovszky, Wesley K Lord, and Becky Rose. Ultrashort nacelles for low fan pressure ratio propulsors. Journal of Turbomachinery, 137(2):021001, 2015.
[2] Thollet, W. Body Force Modeling of Fan—Airframe Interactions. Diss. Ph. D. thesis, ISAE-SUPAERO, 2017.
[3] Minaker, Quentin J., and Jeffrey J. Defoe. "Prediction of Crosswind Separation Velocity for Fan and Nacelle Systems Using Body Force Models: Part 1: Fan Body Force Model Generation without Detailed Stage Geometry." International Journal of Turbomachinery, Propulsion and Power 4.4 (2019): 43.

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propulsive coupling [4]. Although this method cannot give access to the whole phenomenology of the flow inside the thrusters, it is able to capture first order phenomena with lower computational cost, compatible with preliminary design.

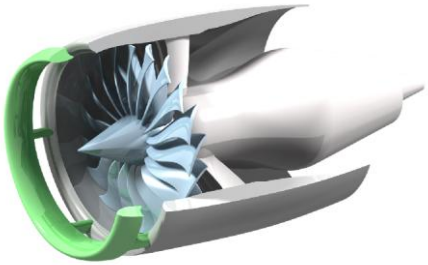


Fig. 1. The slotted-inlet concept (open slot).

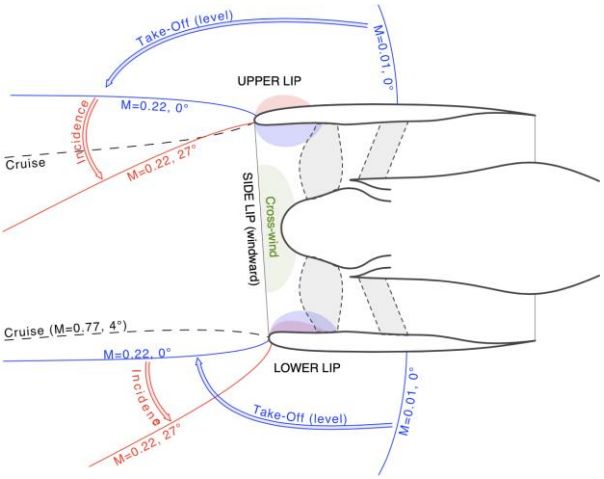


Fig. 2. Stream tube and regions prone to flow separation at different off-design conditions

MISSIONS:

The proposed work will pursue ongoing efforts to develop an adaptive nacelle design framework, using in-house Python scripts for geometry generation, body-force modelling, and the commercial StarCCM+ solver. The objective is to confirm the potential of the slotted-inlet concept by designing a nacelle for a new, given fan design, implementing the slot geometry, setting up body-force modelling of different fan designs, and performing numerical simulations on different off-design conditions including take-off, incidence, cross-wind. We will investigate means to refine the geometry through aerodynamic analysis and shape optimization, and assess actuation requirements in different scenarios (opening/closing the slot in different conditions). We will also explore scaling effects and define requirements for future wind tunnel or flight tests.

[4] Benichou, Emmanuel, et al. "Numerical Low-Fidelity Method for Improved Analysis of Breakthrough Aero-Propulsive Systems ." 1st Aerospace Europe Conference, 2020.

REQUIRED PROFILE:
We are looking for an enthusiastic researcher with a degree in Fluid Mechanics, Energetics or a closely related discipline, with a strong background in computational fluid dynamics, modelling and post-processing techniques (PhD or MSc with proven experience in computational fluid dynamics). Experience in CFD of turbomachinery or aerodynamic shape optimization will be highly appreciated.

As the project is part of a larger European project, collaborative skills are important too. Excellent English, communication and reporting skills are required. Comfort with working both independently and in a team, as well as a pro-active, problem-solving and result-oriented work attitude is highly regarded. The appointee is expected to publish (journal or conference paper), participate in the regular internal project meetings, and contribute to project deliverables.

EXPERIENCE: 0 - 3 years

DURATION : 13 months, with a possible extension after the first 13 months
LOCATION : TOULOUSE

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APPLICATION PROCESS: Applicants should submit their letter of application along with a detailed curriculum vitae, a list of publications, title and abstract of PhD dissertation, contact information of at least one academic reference and all other information that might be relevant to Dr. Nicolás García Rosa (nicolas.garcia_rosa@isae-supaero.fr).

APPLICATION DEADLINE: 14/02/2027
REFERENCES: 2026-slotted-inlet