POST-DOC

PARTENAIRES

Key words: swirl distortion, particle image velocimetry (PIV), hot-wire anemometry, turbofan tests

Department: Department of Aerodynamics Energetics and Propulsion

Experimental Characterisation of Swirl Distortion and its Propagation through a Turbofan Fan Stage.

JOB DESCRIPTION:

Boundary-layer ingestion concepts are being studied as potential subsonic commercial transport aircraft meeting aviation's long-term sustainability targets. This often involves embedding low-pressure-ratio thrusters in the fuselage through diffusing S-ducts, which can generate swirl distortion, on top of the ingested boundary layer stagnation pressure loss. Inflow distortion can lead to fan efficiency penalties.

We developed a test module to recreate stagnation pressure distortion, and swirl distortion at the inlet of a turbofan in a ground test bed (Fig. 1). A rotating duct can hold a variety of distortion generators, and rotate the distortion pattern around the engine axis. The flow can be traversed at different positions (fan inlet, between rotor and stator, and downstream of the fan stage. Steady, total and static pressure, as well as velocity components are measured using five-hole probes, and 2D hot-wire anemometry gives access to axial and tangential velocities at a higher rate, provided the radial component is negligible. Unsteady and turbulent components can be assessed, but the hot-wire's 2D assumption is a strong limitation in vortical flows.

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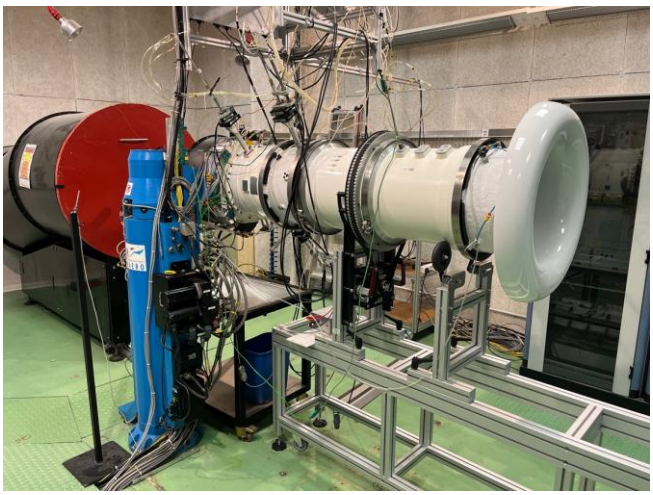


Fig. 1. Turbofan test bed with inlet distortion device.

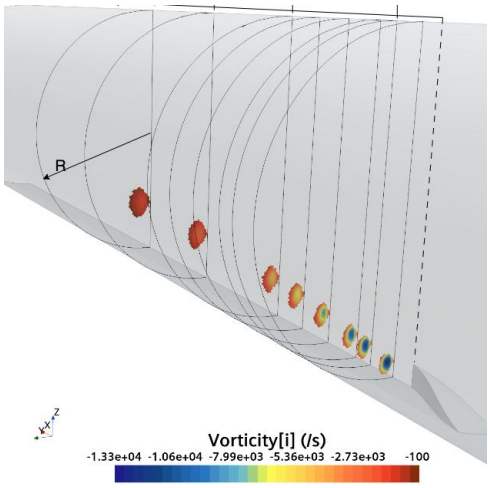


Fig. 2. Numerical simulation of the vortices generated by a delta-type vortex generator.

MISSIONS:

In order to overcome this limitation, we propose to implement (stereoscopic) particle-image velocimetry at the fan interface plane. Existing optical access will be exploited to perform first tests, and new optical access will be commissioned if necessary. Given the large mass flow rate through the engine, we will develop a specific seeding injector that can be traversed across the inlet to seed a region of interest while minimizing its impact on the flow. To this end, aerodynamic shape optimization using RANS numerical simulations will be performed. Different distortion generators will be tested.

In parallel, we will study the transport of the distortion pattern through the fan stage, by means of five-hole or hot-wire probe measurements where applicable. A special attention will be drawn to the temperature and pressure compensation methods for hot-wire anemometry, and the possibility to perform phase-averaging with the rotor blade passing frequency, and employ azimuthal-radial traverses downstream of the fan stator. The generated databases will serve as validation for RANS+body-force numerical simulations conducted in parallel, and contribute to the development of a reference experiment for turbofan distortion studies.

REQUIRED PROFILE:
We are looking for an enthusiastic researcher with a Ph.D. degree in Fluid Mechanics, Energetics or a closely related discipline, with a strong background in computational fluid dynamics, modelling and post-processing techniques. Experience in CFD of turbomachinery or aerodynamic shape optimization will be highly appreciated.
As the project is part of an ongoing experimental project, collaborative skills are important too. Communication and reporting skills in both English and French 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: 3 years

COMPENSATION: 0000€ / AN

DURATION: 18 MOIS

RYTHM: Full time

LOCATION: TOULOUSE

RESPONSIBLE OF THE SUBJECT:
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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-distorsion

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