Aeroacoustics of new engine architectures in aeronautics

ARENA – Industrial chair ANR – Safran Aircraft Engines (ANR-18-CHIN-0004-01)

Future large engines (Ultra-High Bypass Ratio, UHBR) beyond 2025

- UHBR engine vs current engine: shorter and thinner nacelle, larger fan diameter (UHBR, BPR ≤ 15)
- More integrated config. ultra compact nacelle
- Fan design
- High distortion pattern
- Fan inlet interaction
- Reduced fan rotation speed
- Reduced fan/OGV spacing
- Fan/OGV reduced count
- High distortion pattern
- Fan inlet interaction
- Engine/wing/aircraft integration & interaction
- OGV & flowpath design (downstream distortion)

New ways to install the engines

- Semi-buried engine with BLI (Boundary Layer Ingestion)
  (NextGen ONERA Versatile Aircraft - NOVA)
  High-mean flow distortion, and strong inhomogeneous turbulence ingestion
  Architecture: modified aerial excitation to the cabin, modified radiation to the ground, additional struts

Objectives of ARENA

- Understanding and modelling of noise sources in new engine architectures (UHBR and BLI). Investigations will primarily concern all key fan stage areas of noise generation mechanisms but other emerging sources will also be explored
- Understanding and modelling of the effect of the engine installation on engine noise propagation and radiation to the fuselage and to the ground in the far-field propagation
- Development of advanced measurements and analysis methods for investigating fan noise. A strong asset in the ARENA Chair proposal is the wealth of unique experimental facilities available at ECL

Experimental facilities

- LP3 bench – modular installation (rotor/stator, inflow conditions) to develop research work in laboratory, e.g. advanced in-duct modal detection using hundred pressure sensors with the aim of finally implementing these analysis tools in the Phare-2 facility
- Subsonic and supersonic anechoic wind tunnel of the Center for Acoustics (LMFA, ECL)
  Subsonic stream: $M = 0.5$ in a 30 cm × 40 cm cross-section for investigating airfoil noise, and $M = 0.8$ in a secondary nozzle diameter $D = 20$ cm, for the simulation of flight effect on jet noise
  Supersonic stream: fully expanded Mach number $M_f$ ranges up to 1.59 (NPR of about 4.17)

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