Aircraft Noise Reduction Technologies and Related Environmental IMpact

DEVELOPING "GENERATION 3" NOISE REDUCTION TECHNOLOGIES

OBJECTIVES

ARTEM develops novel technologies for the noise reduction of future aircraft. The project was set up in order to help to close the gap between noise reductions obtained by current technologies – as already applied or being matured in large EC technology projects such as OpenAir and CleanSky – and the long-term goals of ACARE, i.e. a noise reduction of 65% for each aircraft operation in the year 2050.

A possible candidate for 2050 air transport: A blended wing body equipped with UHBR engines mounted on the top of the centerbody. A hybrid electric version is also considered (Configuration definition by University RomaTre, 2018).

REDUCE NOISE SOURCES, REDUCE NOISE PROPAGATION, PREDICT THE IMPACT OF NEW AIRCRAFTS AND THEIR NOISE REDUCTION

The first core topic of ARTEM is the development of innovative technologies for the reduction of aircraft noise at the source. The approach moves beyond the reduction of isolated noise sources as pure fan or landing gear noise and addresses the interaction of various components and sources – which often contributes significantly to the overall noise emission of the aircraft.

The landing gear (LG) is a major noise source during the approach – and will remain so also for novel configurations. Beside the actual noise generation at the LG, the aero-acoustic interaction effects with airframe, high-lift-devices and the wing are of great importance. Within ARTEM, tests of different LG configuration are made in the acoustic wind tunnel AWB at DLR Braunschweig in parallel with numerical simulations of other partners.

Secondly, ARTEM addresses innovative concepts for the efficient damping of engine noise and other sources by the investigation of dissipative surface materials and liners. The development work will mature, and subsequently down select these technologies by comparative testing in a single relevant test setup.

The noise reduction technologies will be coupled to the modelling of future aircraft configurations as the blended wing body (BWB) and other innovative concepts with integrated engines and distributed electrical propulsion. The impact of those new configurations with low noise technology will be assessed in several ways, including industry tools, airport scenario predictions, and auralisations.

The auralization lab of EMPA will allow to listen to the novel aircrafts fly-by.

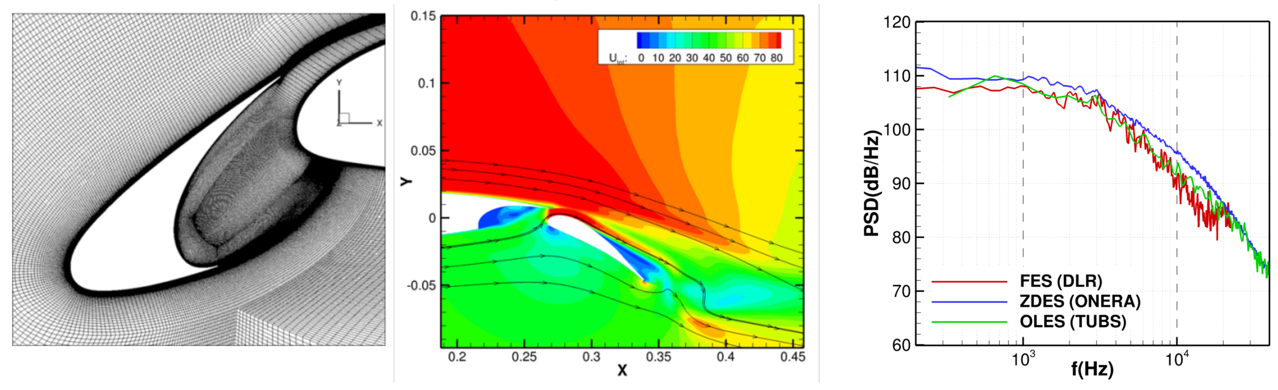
INTERACTING WITH OTHER EUROPEAN PROJECTS

ARTEM directly benefits from the results describing new meta-materials and the development of manufacturing capabilities of the partners engaged in H2020 project AERIALST. The advanced meta-materials application will be assessed and compared to conventional liner technologies, and its application for novel aircraft concepts are going to be explored.

ARTEM results directly contribute to the ANIMA roadmap activity, which supports the future European research activities by providing respective guidance. The conceptual design of a blended wing body aircraft designed in ARTEM is used in ANIMA for 3D visualisation and will be coupled to auralisations.

SELECTED INTERMEDIATE RESULTS

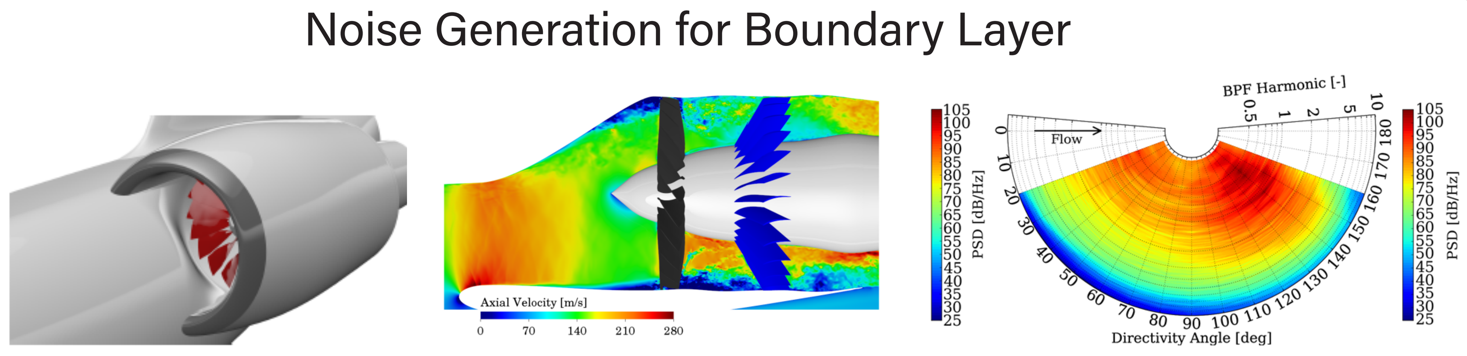
Benchmark for High-Lift-Device Noise



Numerical benchmarks have been made on a generic high-lift-device configuration in order to verify the correct prediction of associated aero-acoustic noise generation. Left: Structured mesh around slat and the leading edge of the airfoil. Mid: Flow field obtained by simulation using DLR code TAU with k-ωSST model. Right: The power spectral densities (PSD) in the shear layer stagnation point as found in the gap between the slat and main airfoil.

The simulations of three partners show a very good agreement (i.e. within 2dB) – an indicator for correct capture of the important slat noise sources by all tools.

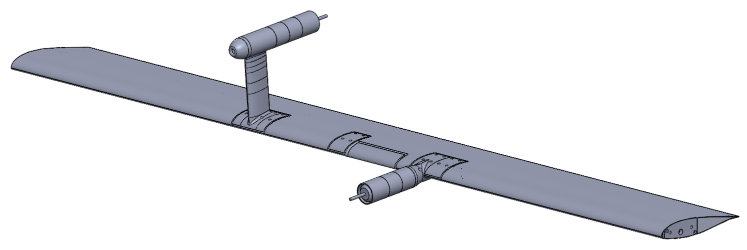
Noise Generation for Boundary Layer



A semi-buried engine installation (SDT engine on NOVA aircraft configuration) was assessed in full-scale using a Lattice-Boltzmann code (TU Delft). Left: sketch of the installation, mid: Instantaneous axial velocity field , right: far-field noise directivity on a circular array of 10 m radius centered around the fan and located below it.

The inflow distortion causes additional noise which is mainly radiated in downstream direction. Of utmost importance for such installations are the design of the S-duct and flow straightening devices in order to reduce the inflow distortion (see bit.ly/fannoiseforNOVA for more details).

Wind Tunnel Model for Distributed Propulsion Investigations



Wing chord [m]	0.3
Freestream velocity [m/s]	30
Propeller diameter [m]	0.28
Propeller number of blades []	3
Propeller tip Mach number []	0.51
Wing Re []	$0.6x10^6$
Wing Mach []	0.09
Propeller RPM [/min]	12000

A wind tunnel model for the investigation of propeller-wing and propeller-propeller interaction has been design by PVS (with partners VKI, INCAS, and ONERA). Both pusher and puller configurations can be investigated. The experiments will yield data needed for model validation and aero-acoustic prediction of distributed (electric) propulsion configurations.

PROJECT IN A NUTSHELL

Start/End date: 2017-12-01 – 2021-11-30
Total cost/EU funding: 7.9 M€/7.5 M€
Coordinated by: DLR, Dept. Engine Acoustics, Berlin/Germany
Call Topic(s): MG-1-2-2017 "Reducing aviation noise"
Partners:

ARTEM and other projects within the MG1-2-2017 call "Reducing Aviation Noise" were initiated by the EREA "Future Sky" initiative.

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