Aerodynamic and Acoustic Installation Effects on Open Rotor Noise

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In recent years, Counter Rotating Open Rotors (CROR) have received considerable attention as the CROR concept promises a considerable reduction of fuel consumption over conventional ducted turbofan engines.

However, the presence of a fuselage, wing, or pylon may significantly change noise characteristics of a CROR as compared to the isolated case. The two main installation effects are: (i) propeller blades operating in non-uniform flow influenced by wing/pylon (source effect), and (ii) propeller sound field interacting with e.g. fuselage, wing, and pylon flow field (propagation effect).

In this contribution the aerodynamic installation effect of CRORs will be investigated on the basis of appropriate unsteady CFD simulations in combination with a porous Ffowcs-Williams and Hawkings (FW-H) solver for the extrapolation of the sound into the far field. The results show that an installed CROR leads to clear non-uniform azimuthal directivities, with increased levels in fuselage direction than towards the sideline. Ground noise polar directivities show the importance of interaction tones for the up- and downstream noise emissions.

Furthermore, aeroacoustic installation effects are studied via a Fast Multipole BEM (FMM) with a simplified noise source model in a quiescent flow. The latter constitutes of a ring source model to represent a CROR. The results show good agreement of this simplified noise source model of a CROR and CFD/CFD+FW-H data for frequencies below 700 Hz. Aeroacoustic installation effects cause an increase in the footprint with respect to uninstalled case, as illustrated in Fig. 1. The interaction tones exhibit a clearly changed directivity, with increased level in the upstream direction.

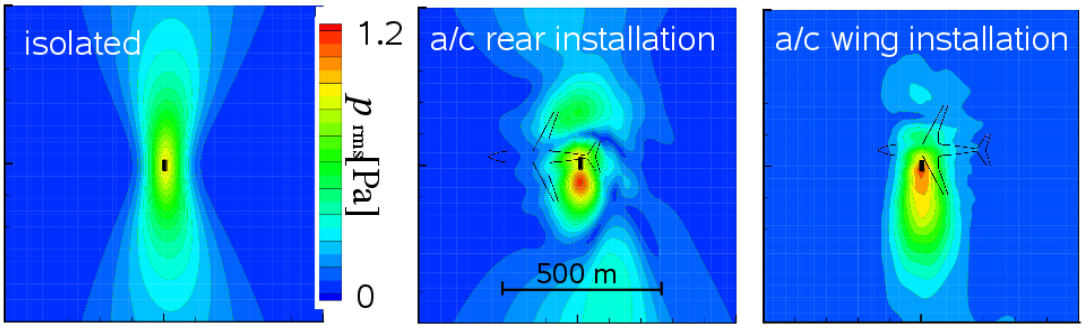

Figure 1: Footprint of loading noise 120m below aircraft for BPF of front rotor for isolated CROR (left picture), installed at rear fuselage (middle), and installed underneath wing (right).