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Investigation of the flow- and sound-field of a low-pressure axial fan benchmark case using experimental and numerical methods

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Abstract (200 words): An extension of a benchmark case for a low-pressure axial fan is presented. The generic fan is a typical fan to be used in commercial applications. The fan design procedure, as well as the experimental setups are described in detail. The numerical approach is based on a forward coupling between a flow simulation with ANSYS Fluent and an aeroacoustic source term and wave propagation computation with multiphysics research software CFS++.

Experimental and numerical data for aerodynamics and aeroacoustics are compared. This includes aerodynamic performance (volume flow rate, pressure rise and efficiency), fluid mechanical quantities on the fan suction and pressure side (velocity distribution and turbulent kinetic energy), wall pressure fluctuations in the gap region and acoustic spectra at various microphone positions. Finally, a comprehensive data base of an axial fan was generated.

Flow field properties at the fan suction and pressure side from the CFD simulation are in good agreement and spectra from the wall pressure fluctuations are in excellent agreement with the experimental data. Spectra from the computed acoustic pressure tend to slightly overestimate the experimental results.

Based on the good agreement of both aerodynamic and aeroacoustic data, a thorough study on the dominant sound generation mechanisms is made.