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Impact of tip-gap size and periodicity on turbulent transition ALEXEJ POGORELOV, MATTHIAS MEINKE, WOLFGANG SCHROEDER, RWTH - Aachen — Large-Eddy Simulations of the flow field in an axial fan are performed at a Reynolds number of 936.000 based on the diameter and the rotational speed of the casing wall. A finite-volume flow solver based on a conservative Cartesian cut-cell method is used to solve the unsteady compressible Navier-Stokes equations. Computations are performed at a flow rate coefficient of 0.165 and a tip-gap size of s/D=0.01, for a 72 degrees fan section resolving only one out of five blades and a full fan resolving all five blades to investigate the impact of the periodic boundary condition. Furthermore, a grid convergence study is performed using four computational grids. Results of the flow field are analyzed for the computational grid with 1 billion cells. An interaction of the turbulent wake, generated by the tip-gap vortex, with the downstream blade, is observed, which leads to a cyclic transition with high pressure fluctuations on the suction side of the blade. Two dominant frequencies are identified which perfectly match with the characteristic frequencies in the experimental sound power level such that their physical origin is explained. A variation of the tip-gap size alters the transition on the suction side, i.e., no cyclic transition is observed.

Alexej Pogorelov
RWTH - Aachen

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