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EXPERIMENTAL MODELING OF LOW PRESSURE TURBINE BLADES AT LOW REYNOLDS AND HIGH MACH NUMBERS

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A detailed experimental analysis of the effects of Reynolds and Mach numbers on the aerodynamic performance of a very high lift, mid-loaded low pressure turbine blade (T106C) is presented. The study was held on a large scale linear cascade in the VKI S1/C high-speed wind tunnel operating at high exit Mach numbers (0.60 … 0.70) and moderate inlet turbulence intensity (0.9 … 3.5 %) with a range of low Reynolds numbers (80,000-250,000). This facility allows an accurate reproduction of the operating conditions encountered in low pressure turbines of modern aero-engines.

Aerodynamic upstream and downstream boundary conditions are accurately quantified in order to provide the necessary input for code validation. Provision is made for the simulation of upstream periodical wakes. This airfoil is characterized by a high pitch-to-chord ratio, implying a significant diffusion, and therefore risk of separation, along its rear suction side. Besides the investigation conducted for steady, uniform inlet conditions, the simulation of incoming periodic passing wakes was also realized. Depending on the operating Reynolds number, the rear suction side flow is characterized by a more or less important (short or long) separation bubble. The bursting phenomenon of the bubble is clearly demonstrated.

The control of the separation is tentatively addressed by means of passive local roughness. Its effect on loss performance is also demonstrated. Besides the knowledge gained on unsteady transition and separation phenomena in low pressure turbines operated at engine similar operating conditions, the large variety of boundary conditions also provides a unique database for code validation dealing with separated flow transition at high Mach number and low Reynolds number in turbomachinery.