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NUMERICAL TRANSITION PREDICTION IN A STRAIGHT TURBINE CASCADE

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The main tasks in improving aircraft turbines are to reduce the losses and to increase the loads. This paper presents experimental and numerical investigations of a straight turbine cascade with the main focus on transition prediction. The turbine blades are designed within the EC project TFAST (Transition location effect on shock wave boundary layer interaction) to increase the loads. Additionally, the acceleration region upstream of the shock is designed for relaminarization of the flow. The retained laminar boundary layer aims to decrease the friction losses.

Experimental investigations are performed at the wind tunnel for straight cascades at the German Aerospace Center (DLR), Göttingen [1]. The wind tunnel operates according to the blow down principle and is supplied with ambient air. The inlet conditions are measured using a hot-wire-probe as well as a 3-hole-probe. Two different incidence angles are investigated at an isentropic exit Mach number of Ma $\approx$ 0.9. To investigate the transition location and the flow field infrared imaging, Schlieren technique (Figure 1), and pressure tappings are applied.

The 3D-flow through the turbine cascade is numerically investigated using the TRACE code. TRACE is developed at the DLR, Institute of Propulsion Technology [2]. Pressure profiles and turbulence levels measured upstream of the cascade are used as inlet boundary condition of the numerical investigation. For transition prediction the γ-Re_θ transition model [3, 4] is utilized. Computations with different turbulence models as the Wilcox k-ω model [5] and the Menter SST k-ω model [6] are performed. In addition various turbulence limiters, turbulence model modification for rotational and streamline curvature effects are applied.

The numerical results are compared to the experimental results. Special emphasis is laid on the influence of the applied numerical settings on the transition location.

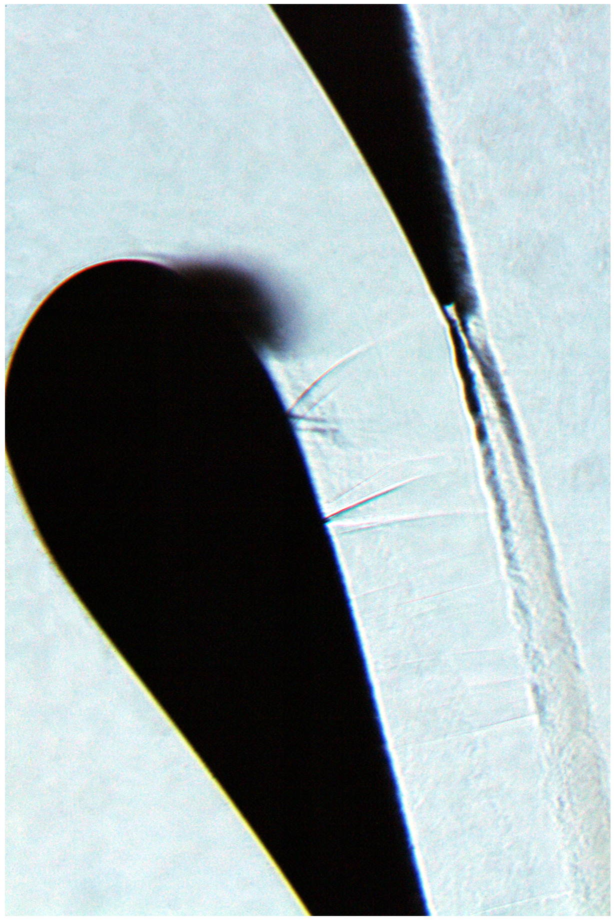

Figure 1: Schlieren picture at isentropic Mach number Ma ≈ 0.9 (knife edge parallel to the blade chord).

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