

Mitteilung

Fachgruppe: Turbulenz und Transition

Influence of Discrete Suction Orifices on Effectiveness of HLFC Surfaces

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To effectively apply Hybrid Laminar Flow Control (HLFC) for drag reduction of transport aircraft, it is desirable to achieve the largest possible laminar flow region with given suction power. Therefore, experimental as well as numerical studies are conducted at DLR.

In past wind tunnel tests with a flat plate with suction in the DNW-NWB, differences in the effectiveness of different suction orifice geometries have been found [1,2]. These are investigated in more detail in recent wind tunnel measurements. Two slotted geometries are compared with nearly homogeneous suction through a four-layer wire mesh (see Fig. 1). Transition locations are determined by infrared thermography, hot-wire and hot-film sensors are used to determine amplitudes of Tollmien-Schlichting waves.

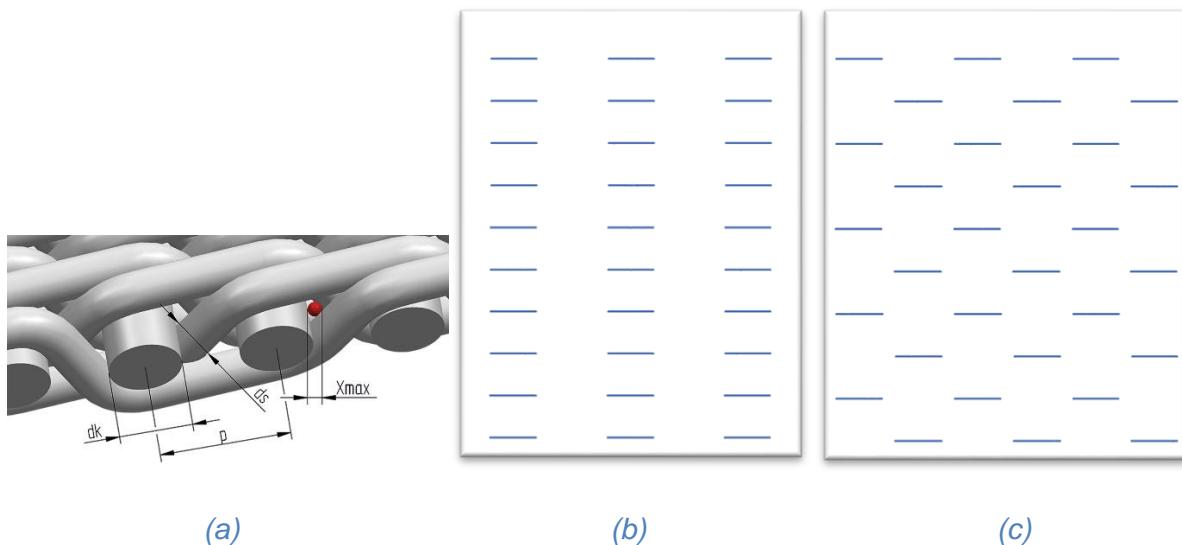


Figure 1: Pore geometries. (a): wire mesh, pore size $9 \mu\text{m}$, from [3], (b): staggered slot pattern, slot size $2 \times 0,045 \text{ mm}^2$, (c): shifted slot pattern, slot size $2 \times 0,045 \text{ mm}^2$

Accompanying the experiments, Direct Numerical Simulations (DNS) of Tollmien-Schlichting waves propagating over discrete suction orifices are carried out. They resolve the three-dimensional disturbances introduced by the suction orifices as depicted in Fig. 2. It can be shown in agreement between experiment and simulation, that certain slot patterns lead to additional stabilisation by longitudinal vortices. This leads to a further down-stream shift of transition additionally to the known stabilising effect of suction. The results match the findings from [4], where a stabilising effect from longitudinal vortices, introduced by discrete roughness elements, is described.

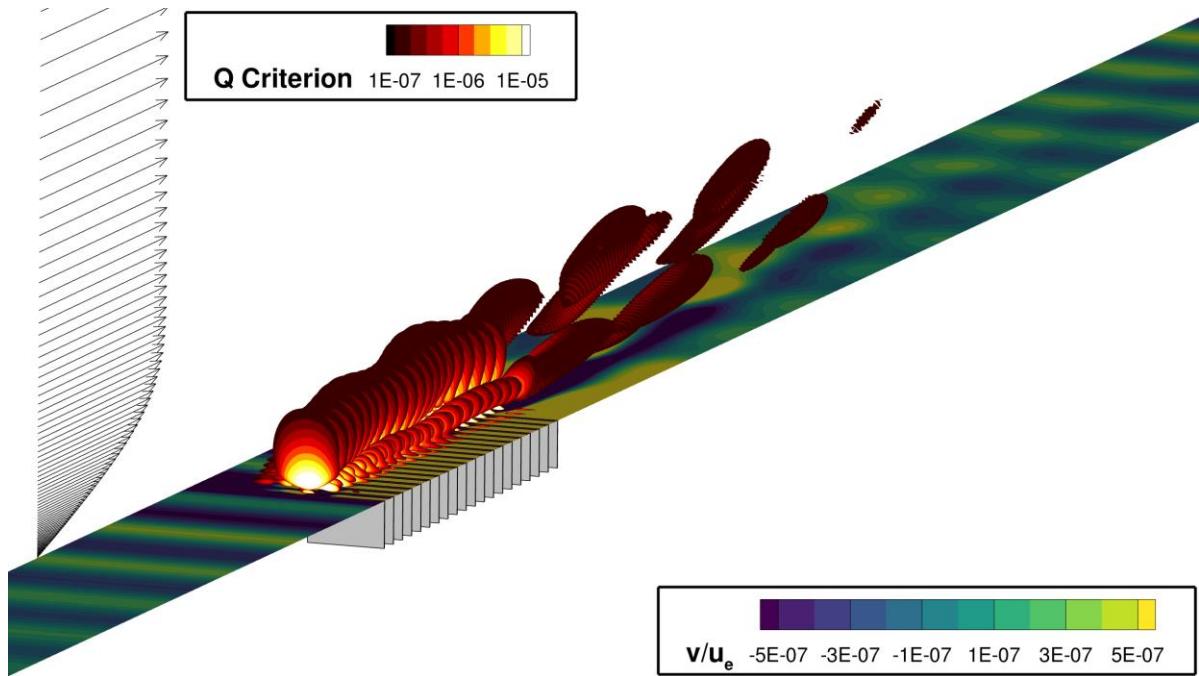


Figure 2: Wall-normal velocity of the disturbance and visualisation of longitudinal vortices by the Q-criterion (DNS results)

The results suggest that by targeted design of suction surfaces, their effectiveness can be improved significantly, which can enhance the benefit of an HLFC system.

The work was part of the DLR project LamTA. We would like to acknowledge the funding by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) under Germany's Excellence Strategy—EXC 2163/1 – Sustainable and Energy Efficient Aviation—Project-ID 390881007. The authors gratefully acknowledge the scientific support and HPC resources provided by the German Aerospace Center (DLR). The HPC system CARA is partially funded by "Saxon State Ministry for Economic Affairs, Labour and Transport" and "Federal Ministry for Economic Affairs and Climate Action." The HPC system CARO is partially funded by "Ministry of Science and Culture of Lower Saxony" and „Federal Ministry for Economic Affairs and Climate Action".

Literature:

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