AERO-THERMAL INVESTIGATION OF A RIB-ROUGHENED TRAILING EDGE CHANNEL WITH CROSSING-JETS

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The need for more and more efficient gas turbines is forcing to a continuous increase of the maximum operating temperature. Nowadays this level exceeds by far the materials' melting point. In order to guarantee its integrity, the gas turbine blade is provided with internal cooling channels in which the heat transfer is enhanced by means of turbulence promoters. An optimum design, i.e. maximizing the heat transfer for a minimum coolant flow rate, requires a deep understanding of this complex three dimensional flow and of the link between turbulent flow structures and heat transfer enhancement.

The present experimental study is devoted to the characterization of the flow field and the heat transfer within a rib-roughened trailing edge channel with crossing jets. The model, machined out of Plexiglass, has a trapezoidal cross-section and presents two rows of slots on two opposite sides. The coolant enters from one side, flows through the inclined slots, impinges on the rib-roughened bottom wall and exits on the opposite side, through the slots along the trailing edge (see figure 1-a).

The flow in the central inter-rib domain of the test section is investigated along several planes by means of Particle Image Velocimetry (PIV). In this way, a very detailed quasi three dimensional view of the flow is attempted and the main flow features are described (see figures 1-b and 1-c). All the results achieved by PIV are compared with the available heat transfer data obtained by means of Liquid Crystals Thermography (LCT). The link between aerodynamic features and thermal characterization is put in evidence through this analysis.

The temperature and velocity distributions in three exit slots are investigated by means of highly spatially resolved measurements. The thermal losses are estimated by this measurements and an important correction on the bulk flow temperature is achieved.

The numerical simulations performed by SNECMA, industrial partner of this project, are compared with the experimental data. The main differences on the mean flow model are underlined and their impact on the predicted heat transfer performance is discussed. An overall good reliability of the present simulations is observed.

Some technical improvements are achieved in the frame of this project. A new background subtraction algorithm for the pre-processing of the PIV images is developed and the possibility of locally biasing the LCT due to the thermal resistance of the Plexiglass ribs is analyzed.

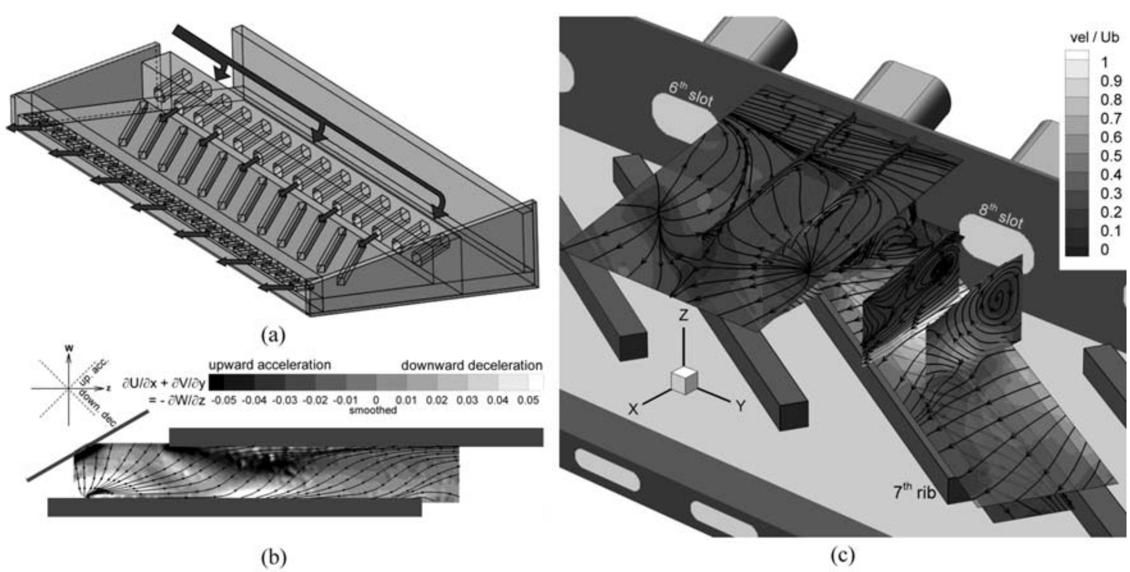

Figure 1: (a) Test section, (b) out of plane acceleration just above the ribbed wall and (c) modulus of the mean velocity and streamlines over all the measurement planes.