AERO-THERMAL PERFORMANCE OF INTERNAL COOLING CHANNELS FOR GAS TURBINES, WITH 45° INCLINED RIBS

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One of the main parameters that designers can vary in order to increase the thermodynamic efficiency of a gas turbine is the turbine inlet temperature. Values over *2100K* are achieved nowadays, exceeding the melting point of the alloys used for inlet guide vanes and rotor blades. The need for cooling these components in the first stages of the turbine is therefore mandatory. For aeronautical applications, a combination of internal an external air cooling techniques is applied, using air bled from the compressor. The presence of ribs inside the channel increases the turbulence level by ripping periodically the boundary layer, enhancing the heat transfer process. The penalty for the presence of the turbulators is the increase of the pressure drop along the channel.

The scope of this research work is the aero-thermal behavior of the flow inside a turbine blade rectangular internal cooling channel, with one or two opposed ribbed walls. The turbulence promoters are square section ribs inclined at *45°* with respect to the mean flow direction, introducing a blockage ratio of $D_h/h=10\%$ for every ribbed wall. The main objectives are to describe the mean flow, to provide new information about the fluctuating flow features in the inter-rib space relevant for the development of the design and analysis tools, and to explain the cooling performance of this highly three-dimensional flow.

In order to have a detailed view of the three dimensional flow field between two consecutive ribs, measurements over mutually perpendicular planes were carried out, by means of Particle Image Velocimetry, into a scaled up glass model of a turbine blade internal cooling channel. To have a more accurate description of the flow, the inter-rib pitch to rib-height ratio distance $\lambda/h=10$ was analyzed in depth. Two planes parallels to the inter-rib wall, in addition to the previous measurements, were considered, as well as seven planes perpendicular to this inter-rib space. These measurements were done respecting geometrical and flow similarity conditions. The data processing provided both mean and *rms* velocity components.

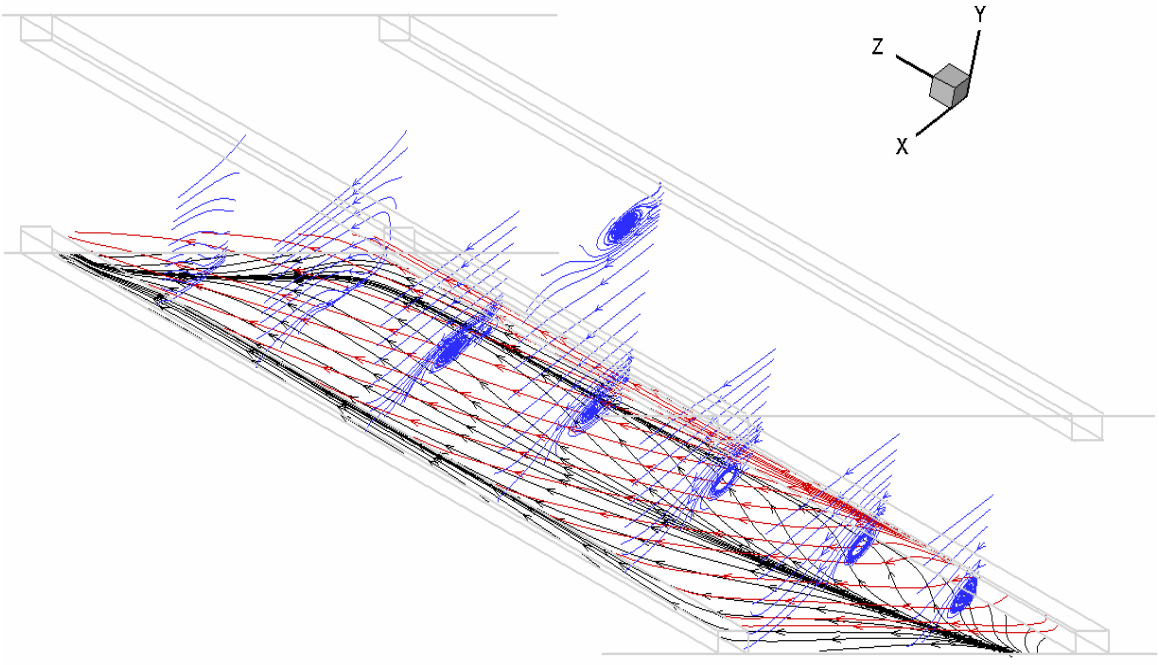

Figure 1: Inter-rib flow field streamlines projection on the investigated planes