INTERNAL COOLING CHANNEL VELOCITY FIELD INVESTIGATION BY MEANS OF PARTICLE IMAGE VELOCIMETRY

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In modern gas turbine engines, the application of turbine blades cooling is absolutely mandatory to allow a high turbine inlet temperature and therefore high thermodynamic efficiencies of the whole engine. The present experimental study concerns the investigation of the turbulent flow inside a rib-roughened turbine blade cooling channel by means of Particle Image Velocimetry (PIV).

The principal aims were to provide new information about the behaviour of such a complicated flow, useful for its understanding, and to create a wide and reliable data base for numerical code validation.
The experiments were carried out on a scaled up model of a turbine nozzle blade cooling channel, working in geometrical and flow similarity conditions. Inside the channel turbulent promoters (or ribs) were installed on one wall. The ribs had an angle of attack with respect to the "mean" flow direction equal to 90° and a blockage ratio equal to 30%.
A global three dimensional view of the flow was attempted by measuring the whole flow filed in between two consecutive ribs over different and mutually perpendicular planes, as presented in the figure below.

Where the data were available, those measurements were compared with previous ones, showing a remarkable agreement, and with some numerical predictions of the flow. Moreover, analysing the experimental data in different planes, a lot of information regarding particular flow structures in terms of their localisation and size were found. For some of them, a model describing their evolution was proposed. The combined interpretation of the PIV results and of the available heat transfer measurements on the channel walls, allowed to highlight the existing links between the aerodynamic and thermal behaviour of the flow. The non-isotropic nature of the turbulent phenomena was found to be of fundamental importance in the heat transfer process.

A wavelet analysis was performed within the symmetry plane of the channel. The evolution of the turbulent coherent structures mean characteristics within the flow field was determined. The presence of a “most probable vortex” was also put in evidence.

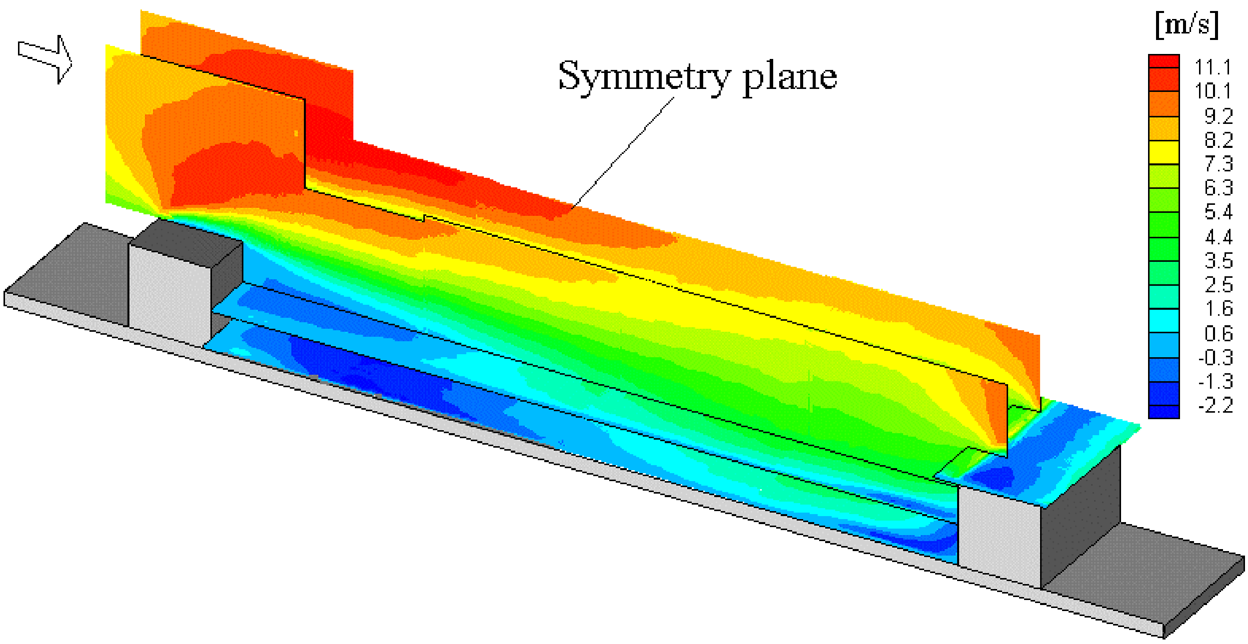

Figure1: Averaged streamwise velocity component contour plots