INVESTIGATION OF THE ROLE OF COHERENT STRUCTURES IN CONJUGATE HEAT TRANSFER OF A RIBBED DUCT APPLYING LARGE EDDY SIMULATION AND PROPER ORTHOGONAL DECOMPOSITION

Béla Kosztin, Hungary
Supervisors: P. Rambaud & C. Benocci

The efficiency of a gas turbine can be significantly improved by increasing its operating temperature. In this case the entry temperature of the turbine may exceed the melting temperature of the blades material, therefore external and internal turbine blade cooling become necessary.

The important role of coherent structures in heat transfer within this flow field has been put in evidence. The present work is concerned with the Numerical Simulation of Flow and conjugate Heat Transfer in a ribbed square channel. This configuration is representative of the cooling channels used for the internal cooling of a turbine blade. The flow will be simulated using the Large Eddy Simulation (LES).

The first aim of this study is to compare our numerical results with former aero-thermal data obtained numerically and experimentally. The Reynolds number of the simulation is 40000, based on the hydraulic diameter and the bulk velocity.

In the second part of the project the author will analyze the obtained flow field by applying Proper Orthogonal Decomposition to investigate the coherent structures contents. Here the first step will be to assess the capabilities of this technique in this framework. POD is expected to bring valuable information based on higher energy or higher correlation in tensors such as the ones formed by the correlation of the turbulent velocity fluctuation versus temperature fluctuation instead of the more traditional vorticity based criteria for the identification of coherent structures.

Two-dimensional Proper Orthogonal Decomposition will be applied with a code which will be written by the author. The purpose will be to identify the structures characterized by the highest turbulent kinetic energy contents. The results will be compared to the ones that have been obtained by other criteria for detection of coherent structures, to assess the performances of POD and its relevance in the understanding of the turbulent heat transfer mechanism.

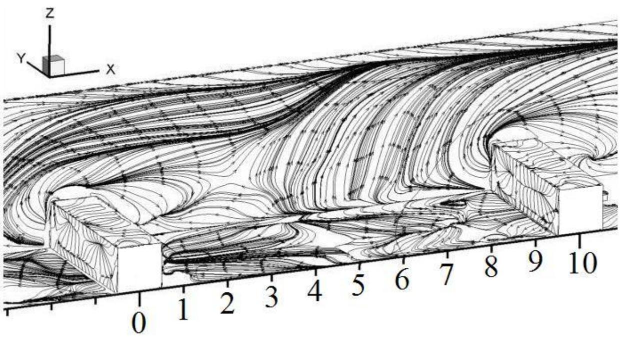

Figure 1: Surface Streamlines

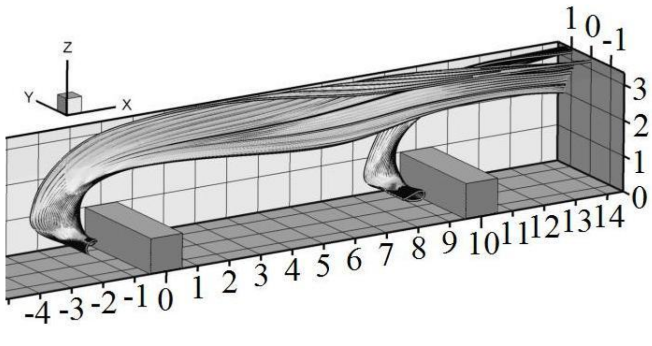

Figure 2: Streamlines

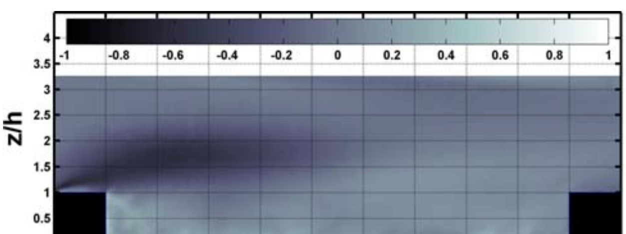

Figure 3: 2nd mode of Temperature

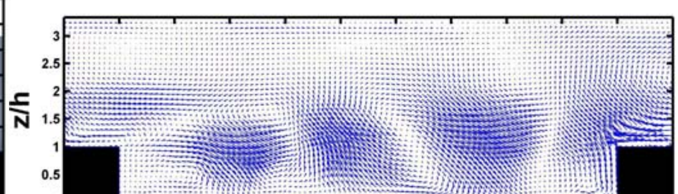

Figure 4: 5th mode of Velocity