HEAT TRANSFER MEASUREMENTS IN A TRANSONIC TURBINE STAGE USING THE THIN FILM GAUGES

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The object of this project is to measure convective heat transfer in a HP transonic turbine stage under the presence of strong shocks. Measurements have been performed in the compression tube facility CT3 using the double layer thin film gauge technique for the stator and both single and double layered gauges for the rotor. The double-layered thin film gauge consists of a nickel deposit on a polyamide sheet that is wrapped around the blade. In contrast, the one layer ceramic-based requires machining of the blades. The double layer gauge presents an improved signal to noise ratio with respect to the single layer ones, leading to a better resolution of the unsteady phenomena present in the flow field.

A crucial aspect of the double-layered thin film gauge technique is the calibration of the thermal product $\sqrt{rCk}$ (where ? = density, C = specific heat and k = conductivity). A hot air jet to simulate a step test has been used. An optimization technique combined with a numerical scheme (that solves unsteady heat conduction equation) already developed has been used to perform the calibration of one gauge on the suction side of the stator blade. Heat flux rate around the stage airfoils is computed using the measured surface temperature histories as a boundary condition and computing the heat flux from the solution of the unsteady conduction equation.

Experiment were performed both in the static and relative frames at three different pressure ratios (P_{01}/P_{S3} from 2.8 to 5.1). Time averaged and time resolved Nusselt number distributions around the profiles have been obtained, for the stator at mid-height and for the rotor at three different blade heights. The results obtained for the rotor have been compared with previous studies, showing a good agreement. In the figures below the steady Nusselt number distribution around the stator with the relative isentropic Mach number distribution (on the left) and the Nusselt number around the rotor blades (on the right) for three different pressure ratios are plotted in function of the non dimensional curvilinear coordinate.

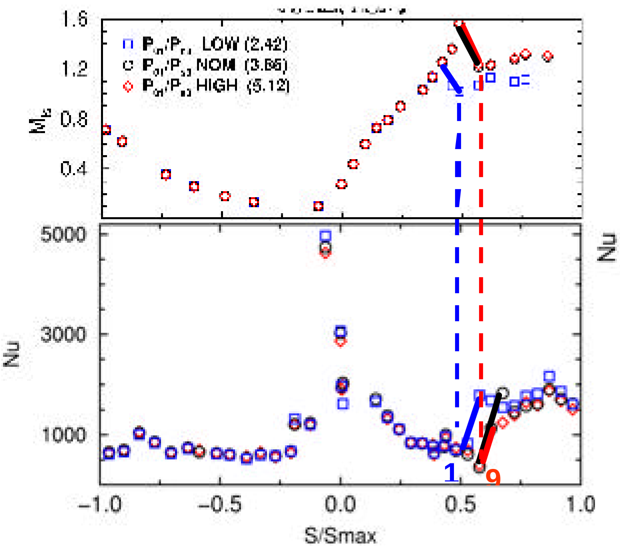

Figure 1: Stator steady Nusselt/Mach number distribution

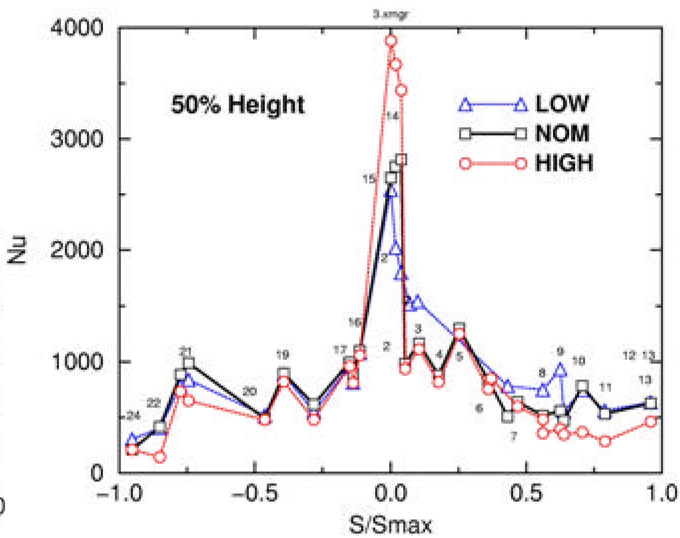

Figure 2: Rotor steady Nusselt number distribution