Numerical study of the effect of the gas to wall temperature ratio on the bypass transition

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The study of boundary layer transition plays a fundamental role in the field of turbomachinery; the main reason is the strong influence of the transition on the flow field local parameters such as skin friction and heat transfer, this variation of the local parameters is reflected on global ones such as overall efficiency of the blade row and of the machine. The understanding of the laminar turbulent phenomenon can help designers to improve aerodynamic and thermodynamic performances of components and of the whole machine. Transition models are nowadays commonly used tools in both CFD research and design practice. It is then of particular interest to understand if the commonly used transition models can predict the effect of temperature on bypass transition and, in case of positive answer, the reasons of their behaviour. This becomes particularly interesting as commonly used transition models start from assumptions that are unlikely to be verified in the considered environment. The chosen transition model are: the $\gamma - Re_\theta$ transition model of Menter and Langtry and $k - k_l - \omega$ of Walters and Cokkjat because of the different kind of approach to the same problem. In order to isolate the effects of the temperature ratio on the transition the simulations have been performed keeping the same values of Reynolds and Mach number and reaching the desired value of the temperature ratio varying the freestream or varying the blade temperature. Then the results have been compared between them in order to check the consistency of the models and then compared to experimental results in order to understand their capabilities in describing the real physics. The results obtained are quite encouraging for the $k - k_l - \omega$ that shows to be able to reproduce, although in a qualitative way, the behaviour observed in the experimental campaign.

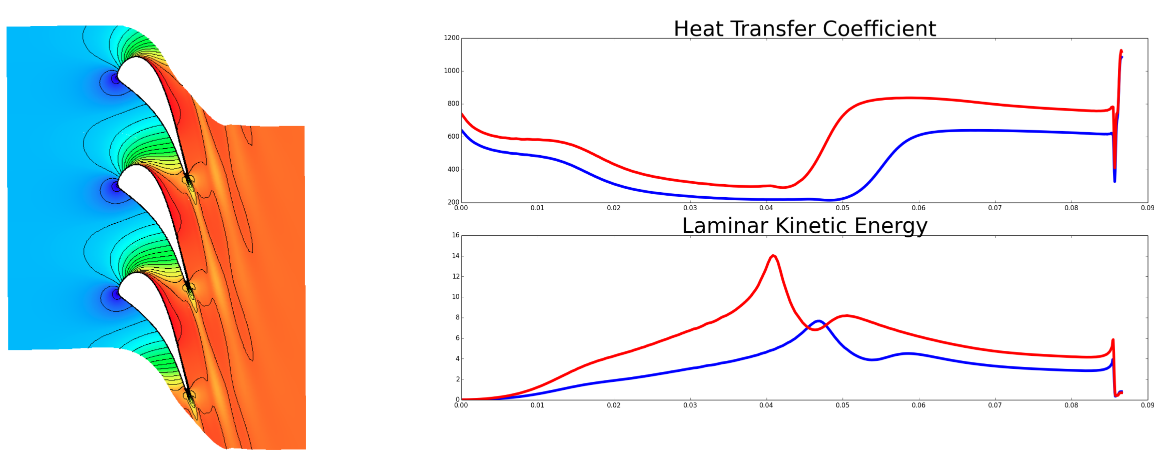

Figure 1: LS 89 profile (left) and evolution of the heat transfer coefficient and laminar kinetic energy along the Suction Side of the profile for two different temperature ratio (right)