Von Karman Institute for Fluid Dynamics

RESEARCH MASTER PROJECT – ACADEMIC YEAR 2016-2017

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

Abstract by Riccardo Rubini

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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 and on global ones such as overall efficiency of blade row. The understanding of the laminar turbulent phenomena can help designers to improve aerodynamic and thermodynamic performance of the machine. Moreover a better understanding of the link between aero thermal field and transition could help the designer to implement more accurate design strategies.

Transition models are nowadays commonly used tools in both CFD research and design practice. It is then of particular interest to understand to what extent a commonly used transition model can predict the effect of temperature on bypass transition and, in case of positive answer, the reasons for this. This becomes particularly interesting as commonly used transition models start from assumptions that are unlikely to be verified in the considered environment (e.g. constant turbulent Prandtl number). The main tool that will be used for the project is Numeca/FINETurbo CFD code using γ-Re_θ (Menter and Langtry) transition model. During the project the possibility to implement in the solver additional transition model (e.g. k-k_l-ω (Walters and Cokkjat)) thanks to Numeca/FINEOpen with Openlabs will be evaluated, together with the option of using other solvers which have it already implemented depending on the availability of licenses.

The project will be structured as follow :

At first the geometry is imported in Numeca/Autogrid and a structured mesh is created, once the mesh is generated a grid dependency study will be performed. Some steady and fully turbulent simulations will be performed varying the Reynolds Number from low to quite high values, Mach number from subsonic to a transonic region and finally the turbulent intensity. It has been seen in previous studies (Tania Ferreira 2016) that the acceleration parameter plays a fundamental role in the onset of transition and on the possibility of flow relaminarization. The simulations will be used to find an operating for which the profile has a pressure distribution such that the acceleration parameter is suitable to capture the possible dependency on T_w. Once understood the right interval of physical parameters simulations with the γ-Re_θ will be performed and the capabilities of describing this kind of phenomena evaluated thanks to a comparison with the experimental data obtained on the same test case at von Karman Institute on a companion RM project.

Resources:

- Medium use of Computer Centre

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