# ANALYSIS OF THE TRANSIENT INLET FLOW FIELD TO THE CT3 TURBINE TEST RIG

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In the attempt to make possible highly accurate measurements, at relatively low cost, of the aerodynamic performances of the jet engine turbines, a technology based on short-duration testing techniques has been developed over the past two decades. In this respect a compression tube annular cascade facility (CT3) was constructed at the von Karman Institute to investigate the aerodynamic heat transfer performance of real size aeroengines/gas-turbine components. A detailed sketch of the test section is showed below. Different measurements were performed in the test section, which needs further development in order to reach the target of less than 1% of uncertainty on the turbine efficiency.

The "starting point" for such a task is a better understanding of the unsteady process that takes place through the main elements of the facility; this can be based on a appropriate numerical simulation of the blowdown, which is the objective of the present project. In this first approach to the problem, a quasi one-dimensional approach, based on the quasi 1-D Euler equations in conservative form, has been used, and applied to an equivalent 1-D channel with variable cross section. In order to analyze the effect of the gradual opening of the valve that precedes the test section a more general formulation is used, which allows to describe the variation of the cross section as a function of time. Pressure losses and convective heat flux are taken into account by suitable additional terms in the momentum and energy equations, by means of engineering correlation formulas.

The numerical method used to solve the hyperbolic system of Euler equations in conservative form is based on the Runge-Kutta time discretization with a suitable form of artificial dissipation (Jameson, Swanson & Turkel). The Fortran code developed for this analysis has been validated against steady and unsteady problems: transonic convergent-divergent nozzle and shock tube problems.

Unsteady calculations have been performed for three different cases: instantaneous opening, gradual opening, and finally gradual opening with pressure losses and heat flux. Even if the model may not exactly represent the physical situation, it should properly describe the basic structure and behaviour of the flow, as well as analyse the relative importance of the different factors included in the computation. The comparison with the experimental results at the inlet of the test section show a quite good agreement for the total pressure. The discrepancy shown for the total temperature seems to be due to two/three-dimensional effects, and heat conduction of the real gas.