LOW SPEED LINEAR CASCADE CHARACTERIZATION THROUGH LASER TECHNIQUES

B. Lazaro, E. Gonzalez
School of Aeronautics, UPM Madrid
Pza. Cardenal Cisneros 3
E-28040 Madrid, Spain

R. Vazquez, D. Cadrecha
ITP
Parque Empresarial San Fernando
Avda. Castilla 2, Edificio Japon
E28830 San Fernando de Henares, Spain

ABSTRACT

The paper describes the use of non-intrusive laser techniques in the characterization of low-speed linear cascades, when applied to the study of low-pressure turbine stages.

The experimental set-up and techniques are first briefly introduced. The former consists of a continuous flow, wind tunnel confined in a closed experimental cell. Experimental techniques include the use of high precision differential pressure sensors, flow temperature probes, and a latest generation, two-dimensional laser-Doppler velocimetry (LDV) system (figure 1a).

The mayor characteristics of the experimental process are next presented. Anemometry characterizations of the cascade upstream and downstream flow are based on LDV measurements. Advantages and disadvantages with alternative cascade characterization methods such as multipoint pressure probes or hot-wire system are discussed. Specific problems associated to the use of the LDV technique are outlined. In particular, seeding methods are briefly discussed. In addition, post-processing strategies associated to the discontinuous character of the LDV technique are addressed.

The evaluation of global cascade merit parameters such as the loss coefficient using the LDV measurements is also analyzed. The loss evaluation procedure is presented. It is based on the determination of the isentropic velocity along the downstream measurement traverse. This is achieved by using the LDV turbulence measurements to determine the potential flow region. The isentropic velocity in the wake region is obtained from the potential data and by exploiting the flow periodicity properties. An estimate of the errors introduced by the whole procedure is obtained using detailed CFD calculations.

The numerical results are also used to evaluate the optimum downstream distance to perform the loss coefficient calculation based on LDV measurements. The extension of the loss calculation procedure to include cascades exposed to upstream non-uniform total pressure flow is also outlined.

Some application examples are presented. Characterizations were performed using a present generation, low-pressure turbine cascade. Standard anemometry measurements are discussed, including mean velocities, turbulence measurements, and flow angle traverses. Loss coefficient measurements are also analyzed. Finally, the potential of laser based techniques for more detailed measurements is outlined, including secondary flow determination or unsteady, phase-locked characterizations (figure 1b).

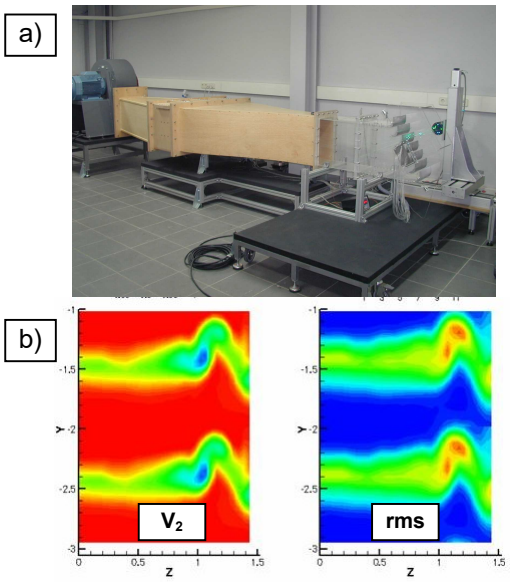

Figure 1: a) General view of the low-speed linear cascade with LDV system. b) Secondary flow characterization.