LOW REYNOLDS NUMBER FLOW WITH HEAT TRANSFER IN ROTATING CHANNELS

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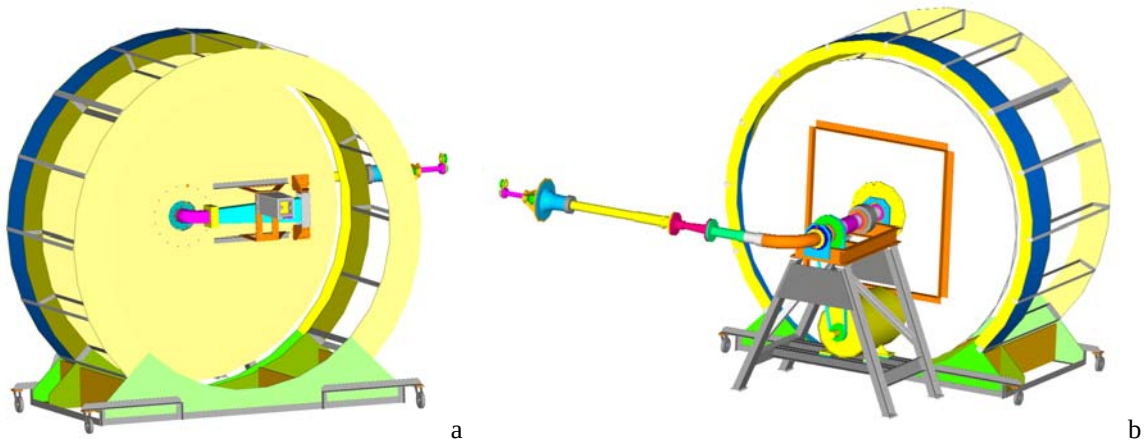
The flow in micro gasturbines impellers and cooling channels of large turbine blade is characterized by low Reynolds number, Coriolis forces and a considerable heat transfer. Performance analysis and optimization of those devises are possible only if the Navier- Stokes solvers correctly account for those phenomena. The main purpose of present project is the design of an experimental facility and instrumentation that can provide detailed information on the flow to validate the analysis methods. Data in the literature do not show sufficient detail and often do not match the parameters of our project.

The facility consist of a rotating divergent channel of 1 m length mounted on a rotating disk to reproduce the impeller passage while respecting the main scaling parameters: Reynolds number from $3{\cdot}10^3$ to $3{\cdot}10^4$, Rotational number between 0.1 and 0.55 and Buoyancy number up to 0.73 (at 1 m/s fluid velocity and 80°C wall temperature). Replacing the divergent channel with a parallel walled channel allows the simulation of a cooling channel.

Detailed flow measurements are possible by means of Particle Image Velocimetry in which the light sheet is produced by means of a continuous laser and images are taken with a high speed camera, both rotating with the channel (Fig. 1a). The main advantage of this system is a direct and hence more accurate measurement of the relative velocity and the time accurate measurement of the flow variations. The PIV system has already been tested in a non-rotating channel and has proven to allow accurate results. Covering the transparent walls with a layer of Indium Tin Oxide allows heating of the walls up to 80.^{o}C while conserving the transparency of the walls. The mass flow is measured by means of a Venturi connected with a seal to the rotating channel and velocity is adjusted by means of an upstream throttle valve (Fig. 1b).



a b

Figure 1: Front (a) and back (b) view of the rotating facility with seeding collector.