TIME RESOLVED PIV MEASUREMENTS IN A ROTATING CHANNEL

Part I: The RC-1Facility; measurements in a rotating diverging channel

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Abstract

In this lecture 2D time resolved PIV measurements of the flow in a low aspect ratio diffuser for turbomachinery applications with spanwise rotation are presented. The PIV instrumentation is mounted with the diverging channel on a rotating disk, allowing a direct measurement of the relative velocity. It is shown that the direct acquisition of the data in rotation reduces the measurement uncertainty. The effects of rotation on the boundary layer are analysed in detail.

1. Introduction

CFD is intensively used for the design of micro gas turbines centrifugal compressors and internal cooling channels of macro gas turbines[1][2][3][4]. But the turbulence models implemented in commercial CFD codes have been mostly tested against experimental data taken at high Reynolds number and in stationary conditions. The not fully-developed inlet flow in real conditions require very accurate and detailed measurements of the inlet conditions, not always available in literature. Therefore some limited validation, even though not in the strict sense of the word, was done in literature using the results of DNS computations.

Although some corrections terms for rotation were developed, Johnston, one of the first experimenters to provide early measurements in rotation [5][6], defined in 1998 the state of the art in turbulence modeling due to the rotation effects as “rather primitive”. Since then progress was made in developing corrections terms [7][8][9][10] , which require validation with detailed experimental data.

Existing literature in the field of experimental data for rotating flows is limited to point-wise measurements of the time- resolved relative flows or to bi- dimensional acquisitions of the phase locked, absolute velocity flow field. Scope of the present work was to design and build a new facility to provide accurate, spatially and temporally well-resolved experimental data for low Reynolds number flows in rotation. The experimental data are used to verify the accuracy of the numerical predictions and/or to give an input for the development of new corrections terms in the turbulence models.

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