Symposium 25 Years of PIV in Aerodynamics, Göttingen, September 23-25, 2009

PIV-measurements of self-induced periodic flow

Rana Badreddine, Martin Lawerenz
Department of Turbomaschinary, University of Kassel

Abstract

A new measurement and evaluation process in order to identify unsteady, self-induced periodic flow fields is presented. The objective is, to investigate such procedures with the conventional PIV system. Parallel to PIV, measurements with the hot wire anemometry are being carried out. Such unsteady self-induced phenomena occur in turbomachines, as shown in the work of Weidenfeller[3] and März[2] for the investigation of rotating instabilites. The Karman vortex street and the rotating instabilities both represent self-induced periodic flow processes. The similarity of both flow forms is being used in this presented work in order to verify the functionality of the procedure in preliminary researchs. The main idea of this evaluation method is, to allocate the phase angle of the PIV- shots relative to the periodic vortex shedding. Hereby, the hot wire signal is used and is being analysed with a statistic procedure based on FFT, in order to sort out the PIV shots and allocate to each an phase information. The taken shots will be indicated in the time signal. Around the PIV indications an adequate window length from the hot wire signal will be chosen for the signal analysis. In this process the frequency with the greatest amplitude gives a clue regarding the fundamental frequency. The development of the amplitude of the fundamental frequency serves as a criterion. After the definition of the time window length a phase angle can be related to the PIV-shot and also the periode is determined. In this way every PIV-shot can be allocated to different classes according to their phase angles. The statistic evaluation of the PIV-shots of each class is then being carried out in the conventional ensemble averaging. The result of such an analysis is shown exemplarily in Fig.1: The field of the velocity vectors as a result of the PIV measurement. In order to clarify the structures of the vortex a velocity of 0,9 m/s was being deducted. The investigations in the air occurred at a reynold number of $Re = 120$ and a Strouhal number of $Sr = 0.18$.

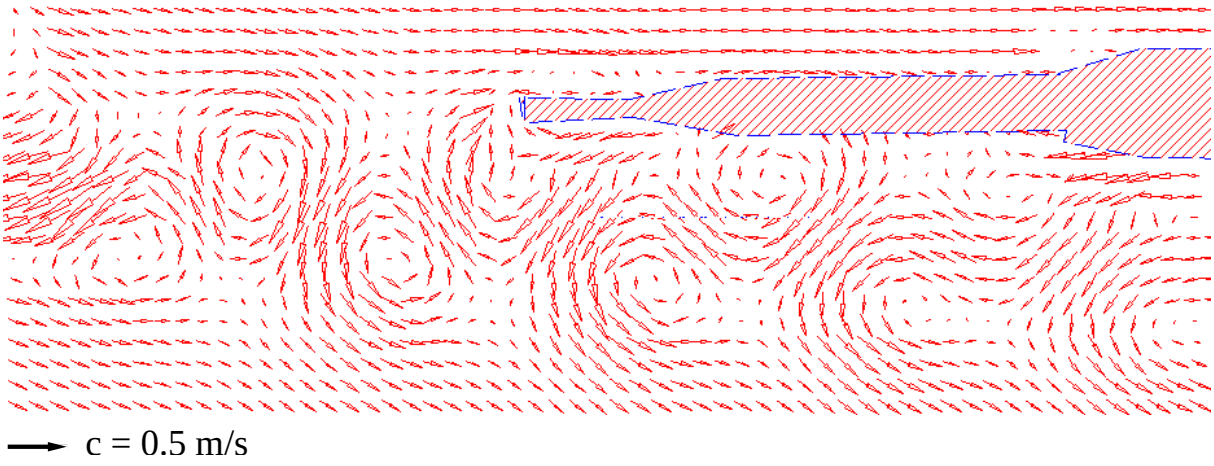

Abb. 1: The field of the velocity vectors as PIV results [1]

Literatur

[1] Rana Badreddine and Martin Lawerenz. Zeitaufgelöste Messung selbsterregter Strömungsfelder durch Kopplung von Hitzdrahtanemometrie und Particle Image Velocimetry. In *Lasermethoden in der Strömungsmesstechnik, 8.-10. Sepetember, Universität Erlangen*. Deutsche Gesellschaft für Laser-Anemometrie GALA e.V., 2009.

[2] J. März, C. Hah, and W. Neise. An experimental and numerical investigation into the mechanisms of rotating instability. In *Proceedings of the ASME TURBOEXPO 2001, ASME Paper 2001-GT-536*, 2001.

[3] J. Weidenfeller and M. Lawerenz. Time resolved measurements in an annular compressor cascade with high aerodynamic loading. In *Proceedings of the ASME TURBOEXPO 2002*, 2002.