Application of Particle Image Velocimetry

-Theory and Practice-

The main interest of todays research in fluid mechanics is more and more directed to problems where unsteady and separated flows are predominant. For investigations of flow fields with pronounced spatial structures and/or rapid temporal or spatial changes (transition from laminar to turbulent flow, coherent structures, pitching airfoils in transonic flows with shocks, rotors, test facilities with short run time, etc.) new experimental techniques, such as Particle Image Velocimetry (PIV) are required which allow to capture the flow velocity of large flow fields instantaneously. An important feature of PIV is that for the first time, a reliable basis of experimental flow field data is provided for direct comparison with numerical calculations and hence, for validation of computer codes. During the last years an increasing number of scientists have started to utilize the PIV technique to investigate the instantaneous structure of velocity fields in various areas of fluid mechanics. A number of different approaches for the recording and evaluation of PIV images have been described in literature. This course, which is the 18th course on PIV since 1993 organized by DLR, will mainly concentrate on those aspects of the theory of PIV relevant to applications. Besides giving lectures on the fundamental aspects, special emphasis is placed on the presentation of practical and reliable solutions of problems which are faced during the implementation of this technique in wind tunnels and other test facilities. During practice the participants will have the opportunity to carry out the recording and the evaluation of PIV images by themselves in small groups. Recent developments of the PIV technique such as 3D(t)-PIV (tomographic and holographic PIV) and Stereo PIV, Time Resolved PIV and Micro PIV will be discussed and demonstrated.

Lecturers

Prof. Michel Stanislas, Laboratoire de Mécanique de Lille, France, is working in the field of Flow Visualization, Holography, and Particle Image Velocimetry. Prof. Stanislas will present the lectures on the optical aspects of PIV.

Prof. Klaus Hinsch, Carl von Ossietzky Universität, Oldenburg, Germany, who has long term experience in the field of Holography, Speckle and Particle Image Velocimetry, will present the lectures on 3D and holographic PIV.

Prof. Jerry Westerweel, Delft University of Technology, The Netherlands, will discuss the theoretical basis of the digital PIV technique, combined PIV / LIF and Micro PIV in his lectures.

Prof. Christian Kähler, UniBw München will discuss Stereo and Multi-plane PIV aspects and the advances in Time Resolved- and long range micro -PIV.

Dr. Andreas Schröder, Institute of Aerodynamics and Flow Technology, DLR, Göttingen, will organize the PIV course, which was established in 1993 by Dr. Jürgen Kompenhans. In the past Prof. Markus Raffel and Dr. Christian Willert (now working in DLR's Institute of Propulsion Technology) have provided the foundations of PIV application in wind tunnels. Together with Dr. Klaus Ehrenfried, Dr. Boleslaw Stasicki, Dr. Robert Konrath, Dr. Reinhard Geisler, Dr. Daniel Schanz, Dipl.-Ing. Janos Agocs and Dr. Fritz Boden from DLR, they will present their knowledge and experience in different areas of the PIV technique such as tracer particles, illumination, recording, evaluation, data presentation, 3D(t)-PIV and other 3C-PIV techniques.

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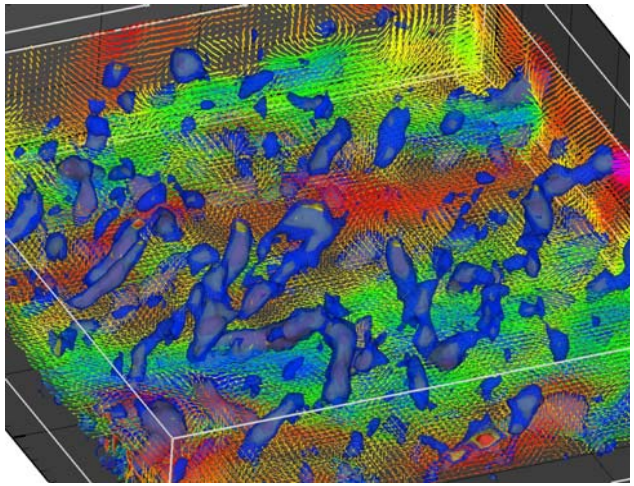

3D -velocity vector fields measured in a turbulent boundary layer flow

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March 22 - 26, 2010

18th course since 1993 to be held at

German Aerospace Center (DLR), Göttingen, Germany

organized by

ERCOFTAC
Pilot Centre 'Germany North'

AG STAB

JM Burgerscentrum
TUD, TUE, UT, RUG, KUN
Research School for Fluid Mechanics

in cooperation with

Laboratoire de Mécanique de Lille,
Delft University of Technology,
University of Oldenburg,
Bw University of München and
DLR, Göttingen

Course Outline

Monday, March 22, 2010
Registration
Welcome by Dr. Jürgen Kompenhans, Head of Department of Experimental Methods, Institute of Aerodynamics and Flow Technology
Principles of PIV technique: Flow tracing by particle imaging, light scattering, recording of PIV images, analysis
Application of PIV technique: Considerations for design of PIV-systems, PIV-systems for wind tunnels
Principles: Statistics of PIV images

Tuesday, March 23, 2010
Application: Digital PIV, video recording, CCD/CMOS sensors
Principles: Theoretical aspects of evaluation of digital PIV recordings, cross-correlation, image deformation, peak detection, evaluation of stereoscopic PIV recordings
Application: Practical aspects of evaluation of digital PIV recordings, measurement uncertainties, Combined PIV / LIF
Practice I

Wednesday, March 24, 2010
Principles: Advanced techniques, optical principles of stereoscopic, tomo- and holographic methods, data validation
Application: Multi plane stereo- , Micro- and Time Resolved– PIV, PIV for multi-phase flows, vector field operators, data analysis and presentation
Practice II

Thursday, March 25, 2010
Practice III and Practice IV

Friday, March 26, 2010
Practice V
Future aspects of PIV technique, Final discussion

Practice (preliminary)
Image capture in wind tunnel: seeding, pulse laser, illumination optics, triggering, CMOS recording, TR-PIV
Image capture in water tunnel: imaging, CCD recording, optical distortions, 3D PIV
Evaluation and post processing: cross-correlation methods, data validation, data analysis and presentation
Optics and holography: imaging, holography
Non standard video and PIV related techniques: video stroboscope, density measurements (BOS)

General Information
The latest information about the course may be found at

http://pivcourse.dlr.de

Program Schedule
Registration will begin at 8:00 on Monday, March 22, 2010 in the Secretary Room of Building 7. Lectures (4 half days) and experiments and demonstrations in the laboratory (5 half days) will run from 8:30 to 12:00 from Monday to Friday and from 13:30 to 16:30 from Monday to Thursday, respectively. All presentations will be given in English.

Course Materials
A complete set of course notes together with the book 'Particle Image Velocimetry - A Practical Guide (2nd Edition)' (published by Springer, 2007) and the USB memory of proceedings of the PIV'09 symposium will be distributed to the participants at registration.

Course Registration
Early registration is required due to limited number of places in the laboratory. Only *Online registration at* http://pivcourse.dlr.de *is possible*. The registration fee of 1100 EURO includes course notes, lunches and refreshments during the course. For payments received before January 28, 2010, a reduced registration fee of 990 EURO applies. The fee for participation is free of VAT as far as the German Umsatzsteuergesetz (UStG) is concerned. The organizers reserve the right to cancel the course in case of insufficient registration. A cancelation fee of 200€ will be charged from registered persons who cancel their participation after March 8, 2010. For students some ERCOFTAC scholarships are available on request.

Exhibition
An exhibition of equipment from major manufacturers of PIV systems will take place from March 25 to 26, 2010.

Additional Information
For additional information about the course contact:

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Who should attend ?
This course is mainly intended for engineers, scientists and students, who have already some basic knowledge of the PIV technique and have just started to utilize PIV for their special industrial or scientific applications or plan to do so in near future. During the course many problems arising in the recording and evaluation of PIV images will be treated - in theory as well as in practice.