

# Application of Particle Image Velocimetry -Theory and Practice -

organized by

LML Lille + Delft Uni of Technology + Uni Oldenburg + UniBw München + DLR  
J.M. Burgers centre and AG STAB

March 20 - 24, 2017

Göttingen

## Monday, March 20, 2017

<b>Lecture</b>		<b>Adolf Busemann Room, Building 7</b>	
08:00	08:30	<i>Registration</i>	
08:30	08:45	<i>Welcome</i>	Dr. L. Koop
08:45	09:00	<i>Organization</i>	Dr. A. Schröder
09:00	10:00	<b>Principles of PIV technique I</b>	Prof. M. Stanislas
		Introduction to PIV	
		Flow tracing by particle imaging	
		- light sources, lasers, light sheets,	
		- particle imaging and diffraction	
		Recording of PIV images	
		- cameras for PIV recording	
		- tracer particles and light scattering	
		- particle velocity lag	
10:00	10:30	<i>Coffee break</i>	
10:30	11:45	<b>Principles of PIV technique II</b>	Prof. M. Stanislas
		Optimization of system parameters	
		Optical interrogation	
		- diffraction and Fourier optics	
		- optical autocorrelation	
		MTF, lens distortion, depth of focus	
		Speckle	
		Optical analysis of double exposure flow records	
11:45	12:30	Self-introduction of participants	
12:30	13:30	<i>Lunch (DLR canteen)</i>	
<b>Lecture</b>		<b>Adolf Busemann Room, Building 7</b>	
13:30	14:00	<b>Application of PIV technique I</b>	Dr. B. Stasicki
		Video recording and LED-illumination	
		Non standard video camera systems for flow visualization	
		Synchronization techniques	
14:00	14:50	<b>Application of PIV technique IIa</b>	Prof. M. Raffel
		DLR PIV-system for wind tunnels	
		- pulse laser, tracer particles, seeding,	
		- imaging, recording	
		Density gradient detection (BOS)	
14:50	15:20	<i>Coffee break</i>	
15:20	16:00	<b>Principles of PIV technique III</b>	Dr. C. Poelma
		Spatial correlation analysis	
		- tracer pattern	
		- ensemble statistics of PIV images	
		Digital PIV recording	
		- discretization, quantization	
		- signal bandwidth	
		- estimation of $R[u, v]$	

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16:00	17:00	<b>Principles of PIV technique III</b> Evaluation of digital PIV recordings - peak detection - noise, accuracy - numerical implementation of correlation algorithms - measurement uncertainties - experimental verification	Dr. C. Poelma
17:00	17:30	<b>Application of PIV technique IIb</b> Image recording for PIV - CCD and CMOS sensors, operation and characteristics - types of CCD and CMOS sensors and application to PIV	Dr. C. Willert
17:30		<i>Welcome party (DLR canteen)</i>	

## Tuesday, March 21, 2017

<b>Lecture</b>		<b>School-Lab, Building 6</b>	
08:30	09:15	<b>Application of PIV technique III</b> Principles of advanced evaluation methods - advanced evaluation techniques - peak detection, normalization of cross-correlation - multipass interrogation, window shifting, image deformation Time resolved PIV - cameras and lasers, types of recording - analysis of image sequences, applications	Prof. C. Kähler
09:15	10:10	<b>Principles of PIV technique IV</b> Stereoscopic PIV - perspective error, translation and angular methods - Scheimpflug condition, image deformation Multiplane (Stereo) PIV for turbulence research - recording and laser system - polarization, frequency and intensity based methods	Prof. C. Kähler
10:10	10:40	<i>Coffee break</i>	
10:40	11:15	Calibration procedure - mapping and de-warping - bilinear interpolation and correction - 3D-Calibration- Polynomial fitting	Dr. K. Ehrenfried
11:15	11:50	<b>Principles of PIV technique V</b> Data Validation	Prof. J. Westerweel
11:50	12:30	<b>Application of PIV technique IV</b> Vector field operators	Dr. C. Willert
12:30	13:30	<i>Lunch (DLR canteen)</i>	
<b>Practice</b>		<b>School-Lab, Building 6</b>	
13:30	13:45	Overview of experiments to be carried out	Dr. A. Schröder
13:45	14:00	Laser safety instructions	Prof. C. Kähler
14:00	17:00	Practice	Group 1, 2, 3, 4, 5 Exp. A, B, C, D, E

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## Wednesday, March 22, 2017

<b>Lecture</b>	<b>Adolf Busemann Room, Building 7</b>	
08:30 09:30	<b>Principles of PIV technique VI</b> Advanced optical techniques - coded-aperture/plenoptic photography - digital holography	Dr. G. Gülker
09:30 10:00	3D- /Tomo PIV - (self-)calibration/ OTF - reconstruction and evaluation	Dr. R. Geisler
10:00 10:30	Advanced PTV using "Shake-The-Box"(STB) - Initialization and track-building - "predict and shake"/ residuals - Lagrangian tracks and Flow-Fit	Dr. D. Schanz
10:30 11:00	<i>Coffee break</i>	
<b>Parallel session 1</b>	<b>Adolf Busemann Room, Building 7</b>	
11:00 12:00	<b>Application of PIV technique V</b> Long-Range Micro-PIV LRM-PIV applied to trans- and supersonic shear layers and separation bubbles on airfoils	Prof. C. Kähler
12:00 12:30	3D-PIV /STB applied to wall turbulence - Lagrangian and Eulerian views PIV in industrial aerodynamics	Dr. A. Schröder
<b>Parallel session 2</b>	<b>School-Lab, Building 6</b>	
11:00 11:40	<b>Principles of PIV technique VII</b> Micro-PIV and applications	Prof. J. Westerweel
11:40 12:30	<b>Principles of PIV technique VIII</b> Combined PIV / LIF technique PIV in two-phase flows	Prof. J. Westerweel
12:30 13:30	<i>Lunch (DLR canteen)</i>	
<b>Practice</b>		
13:30 16:30	Practice	Group 1, 2, 3, 4, 5 Exp. B, C, D, E, A
<b>Celebration</b>	<b>School-Lab, Building 6</b>	
17:00 – 21:00	<b>25<sup>th</sup> PIV Course Anniversary</b> <b>History of PIV developments</b>	Prof. K. Hinsch Dr. J. Kompenhans Prof. M. Stanislas Dr. A. Schröder

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### Thursday, March 23, 2017

#### Practice

08:30 11:00

Practice

Group 1, 2, 3, 4, 5  
Exp. C, D, E, A, B

#### Exhibition

11:00 12:30

#### School-Lab, Building 6

Technical session  
Presentation of PIV system components  
*Lunch (DLR canteen)*

Exhibitors

12:30 13:30

#### Practice

13:30 16:00

Practice

Group 1, 2, 3, 4, 5  
Exp. D, E, A, B, C

#### Exhibition

16:00 19:00

#### Adolf Busemann Room, Building 7

Demonstration of PIV systems to the  
participants of the PIV course

Exhibitors

19:30

*Dinner (Restaurant 'Bullerjahn' at ancient town hall)*

### Friday, March 24, 2017

#### Practice

08:30 11:00

Practice

Group 1, 2, 3, 4, 5  
Exp. E, A, B, C, D

#### Lecture

11:00 12:00

#### School-Lab, Building 6

Future aspects of PIV /PTV techniques

Prof. M. Stanislas  
Prof. M. Raffel  
Prof. C. Kähler  
Prof. J. Westerweel  
Dr. C. Poelma  
Dr. G. Gülker  
Dr. D. Schanz

12:00 12:20

Final Discussion and certificates

12:20

*Lunch (DLR canteen)*

- END -