

# Application of Particle Image Velocimetry

## -Theory and Practice – Online-Course

organized by

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

March 15 - 19, 2021

Göttingen

### Monday, March 15, 2021

#### Lecture

08:30 08:45  
08:45 09:00  
09:00 10:00

#### Online

*Welcome*

*Organization*

#### Principles of PIV technique I

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 10:15

*Coffee break*

10:15 11:00

#### Principles of PIV technique II

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

11:00 11:35

#### Application of PIV technique I

Video recording and LED-illumination

Non standard video camera systems for

flow visualization

Synchronization techniques

Self-introduction of participants

11:35 12:15

12:15 13:15

*Lunch break*

#### Lecture

13:15 14:05

#### Online

#### Application of PIV technique IIa

DLR PIV-system for wind tunnels

- density gradient and boundary layer detection by BOS and DIT

- pulse laser, tracer particles, seeding,

- imaging, recording

Dr. C. Wolf/Prof. M. Raffel

14:05 14:45

#### Principles of PIV technique III

Spatial correlation analysis

- tracer pattern

- ensemble statistics of PIV images

Digital PIV recording

- discretization, quantization

- signal bandwidth

- estimation of  $R[u, v]$

Prof. C. Poelma

14:45 15:00

*Coffee break*

# Application of Particle Image Velocimetry

## -Theory and Practice – Online-Course

organized by

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

March 15 - 19, 2021

Göttingen

15:00	16:00	<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	Prof. C. Poelma
16:00	16:30	<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
16:30		<i>End of first day</i>	

## Tuesday, March 16, 2021

Lecture	Online		
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	<b>Application of PIV technique IIb</b> Calibration procedure - mapping and de-warping - bilinear interpolation and correction - 3D-Calibration- Polynomial fitting	Dr. K. Ehrenfried
10:40	10:55	<i>Coffee break</i>	
10:55	11:25	<b>Principles of PIV technique V</b> Data Validation	Prof. J. Westerweel
11:25	12:20	<b>Application of PIV technique IV</b> Vector field operators	Dr. C. Willert
12:20	12:40	<b>Principles of PIV technique VI</b> 3D- /Tomo PIV - (self-)calibration/ OTF - reconstruction and evaluation	Dr. R. Geisler
12:40	13:40	<i>Lunch break</i>	

# Application of Particle Image Velocimetry

## -Theory and Practice – Online-Course

organized by

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

March 15 - 19, 2021

Göttingen

<b>Lecture</b>	<b>Online</b>	
13:40 14 :40	<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
14:40 15:00	PIV in industrial aerodynamics	Prof. A. Schröder
15:00 15:15	<i>Coffee break</i>	
15:15 15:55	<b>Principles of PIV technique VI</b> Micro-PIV and applications	Prof. J. Westerweel
15:55 16:45	<b>Principles of PIV technique VII</b> Combined PIV / LIF technique PIV in two-phase flows	Prof. J. Westerweel
16:45	<b>End of second day</b>	

## Wednesday, March 17, 2021

<b>Lecture</b>	<b>Online</b>	
08:30 09:30	<b>Principles of PIV technique VIII</b> Advanced optical techniques - coded-aperture/plenoptic photography - digital holography	Dr. G. Gülker
09:30 10:20	Advanced PTV/LPT using “Shake-The-Box”(STB) - Initialization and track-building - “predict and shake”/ residuals - Lagrangian tracks and Flow-Fit	Dr. D. Schanz
10:20 10:35	<i>Coffee break</i>	
10:35 11:05	Multi-pulse STB for high-speed flows - iterative IPR and tracking - online calibration correction and bin-averaging	Dr. M. Novara
11:05 11:45	3D- STB applied to turbulence - Lagrangian and Eulerian views - FlowFit, VGT and 3D pressure - Vortex criteria, dissipation rate	Prof. A. Schröder
11:45 12:45	<i>Lunch break</i>	
<b>Practice</b>	<b>Online-Interactive</b>	
12:45 13:00	Overview of experiments to be carried out	Prof. A. Schröder
13:00 13:15	Laser safety instructions	Prof. C. Kähler
13:15 13:30	Split in groups – technical reorganization	
13:30 16:30	Practice I	Group 1, 2, 3 Exp. A, B, C
16:30	<b>End of third day</b>	

# Application of Particle Image Velocimetry

## -Theory and Practice – Online-Course

organized by

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

March 15 - 19, 2021

Göttingen

### Thursday, March 18, 2021

#### Practice

08:30 11:15

#### Online-Interactive

Practice II

Group 1, 2, 3

Exp. B, C, A

Companies

11:15 12:45

#### Technical session

Presentation of PIV/LPT system components

12:45 13:45

*Lunch break*

#### Practice

13:45 16:30

#### Online-Interactive

Practice III

Group 1, 2, 3

Exp. C, A, B

#### Lecture

16:30 17:30

#### Online

Future aspects of PIV /LPT techniques

Prof. C. Kähler

Prof. J. Westerweel

Prof. C. Poelma

Dr. B. Lecordier

Dr. G. Gülker

Prof. A. Schröder

17:30 17:40

Final Discussion and certificates

### Friday, March 19, 2021

#### Virtual exhibition resp. contact to PIV related companies

09:00 13:00

Contact to PIV related companies via online-tools, weblinks or telephone

- END -