Use of PIV in DNW Wind Tunnels

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Overview

- Introduction
- History and Milestones of PIV in DNW
- Examples of application
- Future aspects
Motivation

Laser Light Sheet flow visualization
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History and Milestones of PIV in DNW

- In 1993 DLR made a feasibility study about the implementation of a PIV system in DNW-LLF.
- After a positive result of the feasibility study DNW asked DLR to make a concept of a PIV system, which is suited to be integrated into DNW measuring systems.
- In 1995 DLR delivered a (mono) PIV system to DNW.
- In 1999 the DNW PIV system has been up-graded to a stereo system in order to achieve 3 components of the flow vector.
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Examples of application

- First application of PIV in the wake of an Airbus half model in the 8 by 6 m² closed test section of DNW-LLF.

- In the following years applications mainly at fixed wing wind tunnel models as well as at helicopter rotors.

- Furthermore, measurements have been carried out in various DNW wind tunnels:
  - Cars, race cars (Formula 1) => NWB
  - Wind mills => LLF
  - Moving belt ground plane (boundary layer) => NWB
  - Airplane engines => LLF
  - Ship decks => LST
  - Generic delta wing model => HST & TWG
Fixed Wing
Fixed Wing
Helicopter rotors
Helicopter rotors
Helicopter rotors
Airplane Engines
Airplane Engines

- Special seeding generator in order to seed into the engine.
Wind Mill
Airplane Engine

- First application at counter rotating open rotors (CROR) in 2008 at DNW LLF
2D Particle Image Velocimetry (PIV)

- First light pulse at $t_1$
- Second light pulse at $t_2$

Light sheet optics
Mirror
Laser
Light sheet
Flow with tracer particles
Illuminated particles
Flow direction
Imaging optics
Image plane
3C Particle Image Velocimetry (PIV)
PIV Set-Ups

- The best suited set-up of the PIV system components is defined in advance of the wind tunnel test campaign.

- In the past 2-dimensional drawings have been made for this purpose.

- In the meantime 3-dimensional drawings are generated by means of special drawing applications on personal computers (e.g. CATIA system).
PIV Set-Ups

- 2-D drawing of PIV set-up for HELIFLOW
PIV Set-Ups

- 3-D drawing of PIV set-up for HELIFLOW
PIV Set-Ups

- Photo of real PIV set-up for HELIFLOW
Interesting Results

- PIV processing of large flow visualization image
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Future Aspects

- Up-grading the PIV system by:
  - Tomographic PIV
  - Time resolved PIV