Laboratory Wind Tunnel/Flow Measurements

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Univ. Appl. Sciences (Fachhochschule)
• Third largest in Bavaria  (>10 000 students)

Main Faculties
• Mechanical Engineering
• Electrical Engineering
• Microsystems Engineering
• Computer Science / Mathematics
• Business Studies

Faculty of Mechanical Engineering
• Largest in Bavaria
• New building (8500 m²)
• total 1200 students
• > 350 freshman-students each year
• 29 laboratories
• BEng. (started WS 06/07)
• MEng. (starting WS 07/08)
Regensburg Wind Tunnel (RWT)

Designed for
• Education
• Research
• Provision of services

Diagram showing various components of the wind tunnel, including:
- Fan
- Turning Vanes
- Test Section open/closed
- Flow Straightener
- Contraction
- Collector
- Diffuser
Regensburg Wind Tunnel (RWT)
Closed circuit „Göttingen“-type wind tunnel

Basic Characteristics

- Contraction ratio \( CR = 6.53:1 \)
- Power consumption \( 18.5 \, \text{kW} \)
- Initial operation \( 05.2006 \)

Closed Test Section (interchangeable)
- Low turbulence measurements
- Sensor calibration, airfoil characteristics
- Contraction exit area \( A = 0.5 \times 0.6 \, \text{m}^2 \)
- Test section length \( L = 1.5 \, \text{m} \)
- Maximum windspeed \( u = 53 \, \text{m/s} (190 \, \text{km/h}) \)
- Rate of turbulence \( T_u_{\text{RMS}} = 0.2\% \)

Open Test Section (interchangeable)
- Good accessibility during tests
- Automotive testing, road simulation (3/4 open) sensor calibration, aeroacoustic measurements, thermography
- Contraction exit area \( A = 0.5 \times 0.6 \, \text{m}^2 \)
- Test section length \( L = 1.1 \, \text{m} \)
- Maximum windspeed \( u = 48 \, \text{m/s} (170 \, \text{km/h}) \)
- Rate of turbulence \( T_u_{\text{RMS}} = 0.5\% \)
Measurement Devices

Force Balance
- 6 component strain gage balance
  - Maximum forces
    - $F_x = 360 \text{ N}$, $\Delta F = 0.01 \text{ N}$
    - $F_y = 360 \text{ N}$, $\Delta F = 0.01 \text{ N}$
    - $F_z = 720 \text{ N}$, $\Delta F = 0.02 \text{ N}$
- Wall pressure measurement method

Flow Visualization
- Fog probe
- Tuft method
- Mini tuft method
- Thermography
Measurement Devices (contd.)

Constant Temperature Anemometry (CTA)
- DANTEC system ‘Streamline’
- Two channels (two directions $u_x$, $u_y$)
- Various hot wires and film probes
- Hot wires for water flow and boundary layer

Five-Hole-Probe
- 3-axis-measurement ($u_x$, $u_y$, $u_z$)

Reference Windspeed Sensor
- DANTEC steel-clad transducer 54T28

Pressure Transducer
- 16 channel pressure scanner PSI type 9116
- HBM and Motorola single channel pressure transducer
Additional Test Set-Ups

Boundary Layer Measurement
- GUNT mini windtunnel HM225
- Pitot Tube or CTA measurements
- Used for sensor calibration

Directional Sensor Calibration
- Two angle frame movement
- Used for sensor calibration
- Fully automated (Labview)
Additional Test Set-Ups (contd.)

Water Channel
- GUNT System HM150

Acoustic Measurements
- Norsonic Nor 130 package

Frontends
- Two HBM Spider 8 Frontend (2x8 channels)
- Several NI ADC (16 bit, 24 bit)
- Data acquisition by Labview

Research
- Influence of boundary layer on airfoil character.
- Optimisation of flow mass sensors (automotive)
- Optimization of wind tunnel turbulence
- Miniaturized probes types for micro air vehicles
- Measurement of wind vectors (meteo)
Diploma Thesis (examples)

Aneurysm Test Set-Up
Christian Klopsch 09.04-02.05
• Experimental studies
• Flow measurements (water) with hot wire probes (CTA)

Aneurysm CFD Calculations
Thomas Schmidt 07.04-02.05
• Numerical CFD solver Ansys CFX-5
Diploma Thesis (contd.)

Direction Dependent Wind Speed Probes
Christian Lackinger 09.04-02.05
• Five-Hole-Probe
• PSI 9116 pressure transducer
• Realisation 'Wörrlein' calibration method

Sunroof Booming
Christoph Schwarzbauer 03.05-08.05
• Generic wind tunnel model
• Kelvin-Helmholtz instability
Cooperations

Cooperations with Universities

• Univ. Munich (LMU)
  Development of special sensors
  Research on valley wind systems

• Univ. Stuttgart
  Contact-free lift and drag determination by measurement of wall pressure signature

• Univ. Regensburg Medical Centre
  Flow patterns in intracranial aneurysms

• Univ. Bergen (Norway)
  Miniaturization of directional wind speed sensors

Industrial Partners

• Krones AG, Neutraubling
• Infineon AG, Regensburg
• Continental, Regensburg
• BERU, Ludwigsburg