Laboratory Wind Tunnel/Flow Measurements

Prof. Dr.-Ing. Stephan Lämmlein
University of Applied Sciences Regensburg

University of Applied Sciences Regensburg

Univ. Appl. Sciences (Fachhochschule)

• Third largest in Bavaria (>10 000 students)

Main Faculties

• Mechanical Engineering

• Electrical Engineering

• Microsystems Engineering

• Computer Science / Mathematics
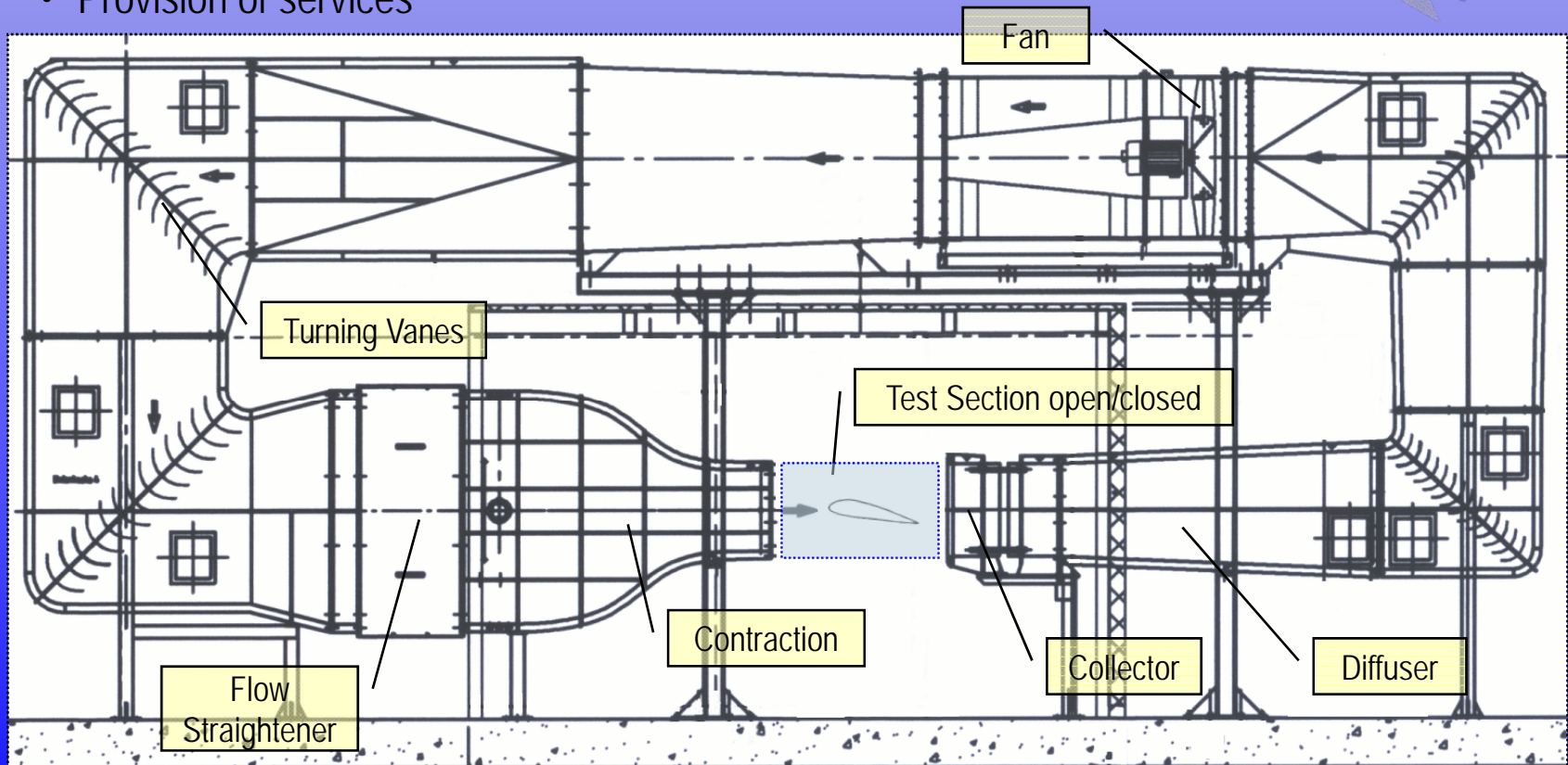
• Business Studies

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)

Labor Windkanal/Strömungsmesstechnik
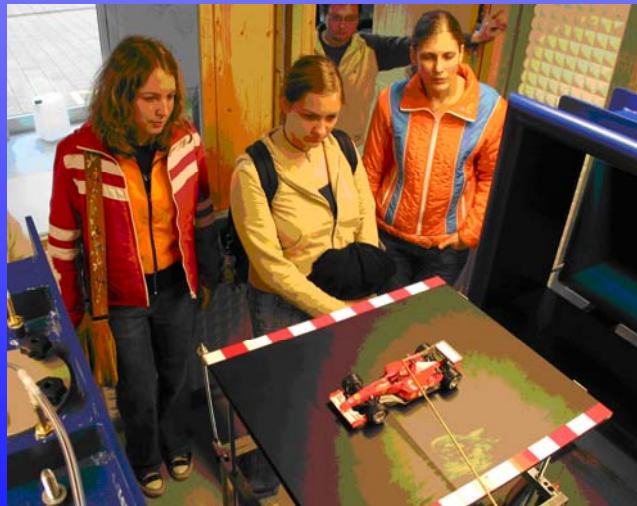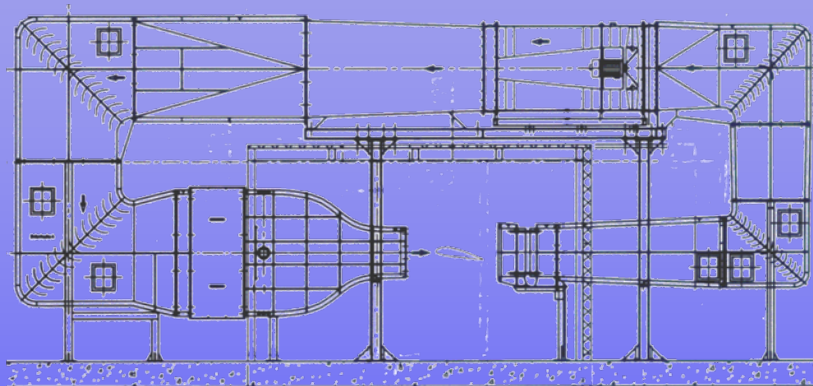
Regensburg Wind Tunnel (RWT)

Designed for
- Education
- Research
- Provision of services

Regensburg Wind Tunnel (RWT)
Closed circuit „Göttingen"-type wind tunnel

Basic Characteristics

Contraction ratio	CR = 6.53:1
Power consumption	18.5 kW
Initial operation	05.2006

### Closed Test Section (interchangeable)

- Low turbulence measurements
- Sensor calibration, airfoil characteristics
- Contraction exit area $\quad$ A = 0.5 x 0.6 m²
- Test section length $\quad$ L = 1.5 m
- Maximum windspeed $\quad$ u = 53 m/s (190 km/h)
- Rate of turbulence $\quad$ Tu_{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 $\quad$ A = 0.5 x 0.6 m²
- Test section length $\quad$ L = 1.1 m
- Maximum windspeed $\quad$ u = 48 m/s (170 km/h)
- Rate of turbulence $\quad$ Tu_{RMS} = 0.5%

Measurement Devices
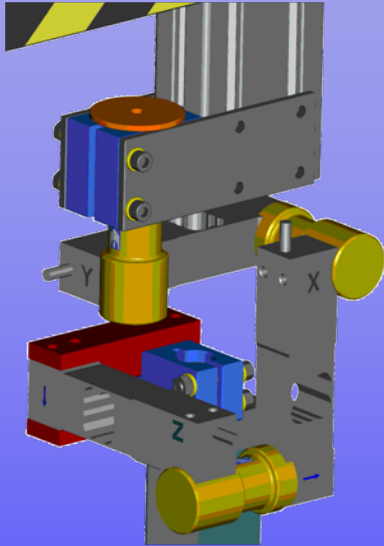
Force Balance
- 6 component strain gage balance
  Maximum forces
  - $Fx = 360$ N $\Delta F = 0.01$N
  - $Fy = 360$ N $\Delta F = 0.01$N
  - $Fz = 720$ N $\Delta F = 0.02$N

- 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
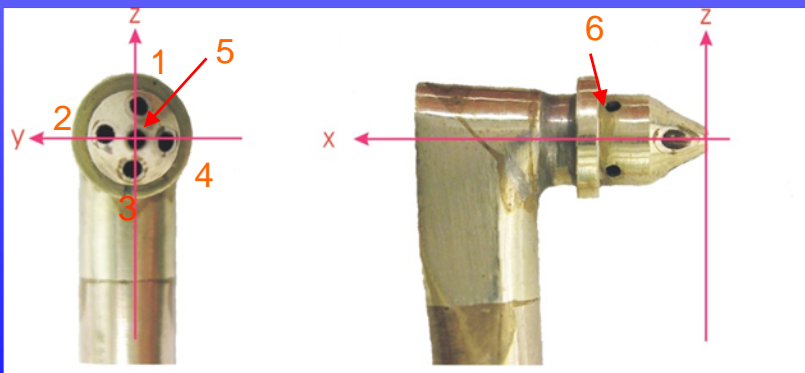- Hot wires for water flow and boundary layer

Five-Hole-Probe

- 3-axis-measurement (u_x, u_y, u_z)
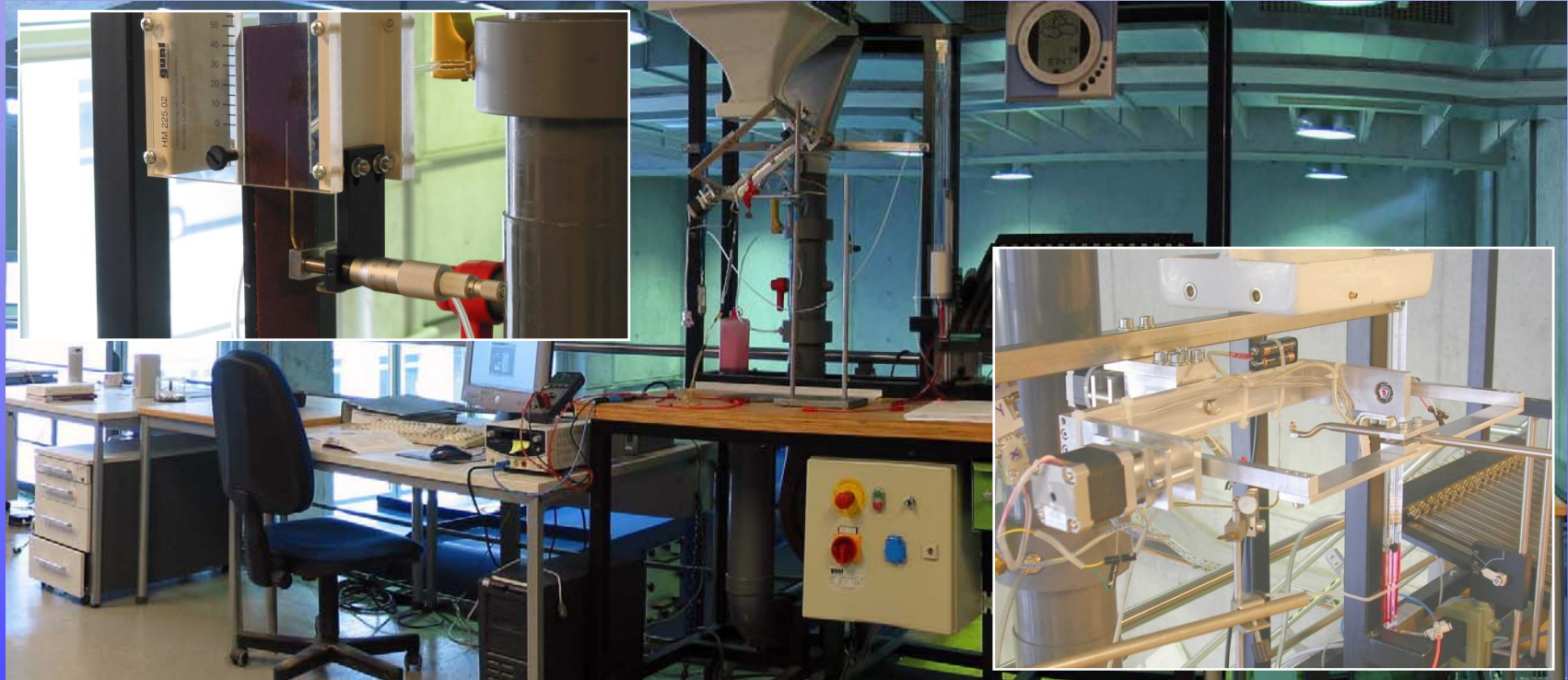
Reference Windspeed Sensor

- 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 (2x8channels)
- Several NI ADC (16 bit, 24 bit)
- Data acquistion by ‚Labview'

Research

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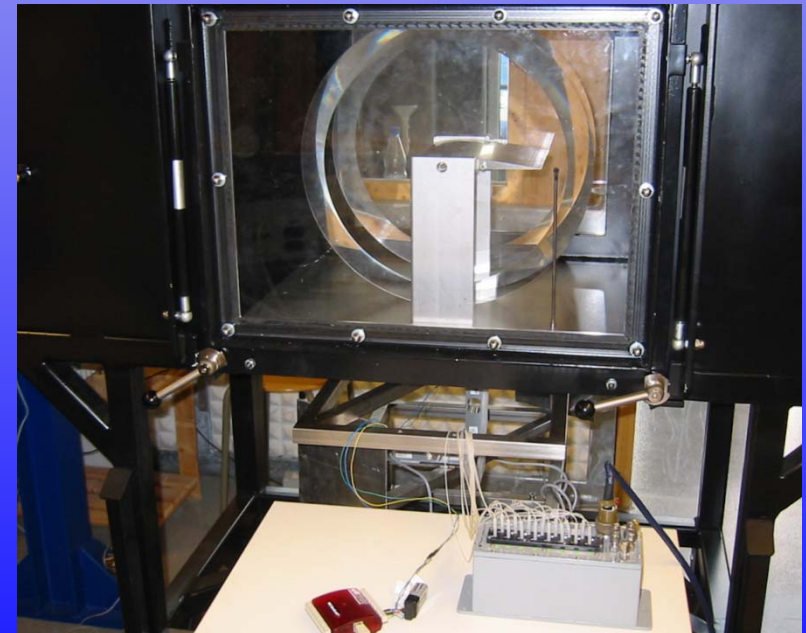
Diploma Thesis (examples)

Aneurysm Test Set-Up
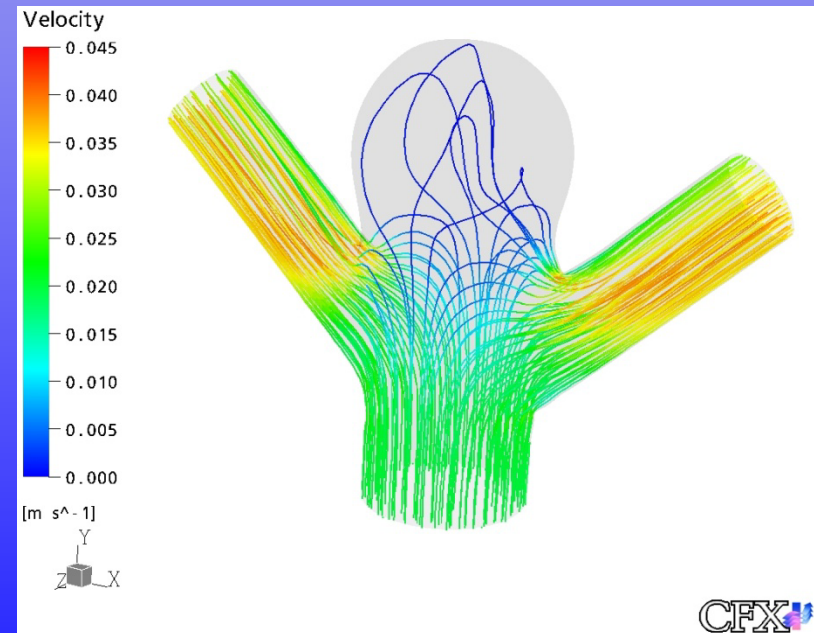
Christian Klopsch 09.04-02.05

• Experimental studies

• Flow measurements (water) with hot wire probes (CTA)

Aneurysm CFD Calculations

Thomas Schmidt 07.04-02.05
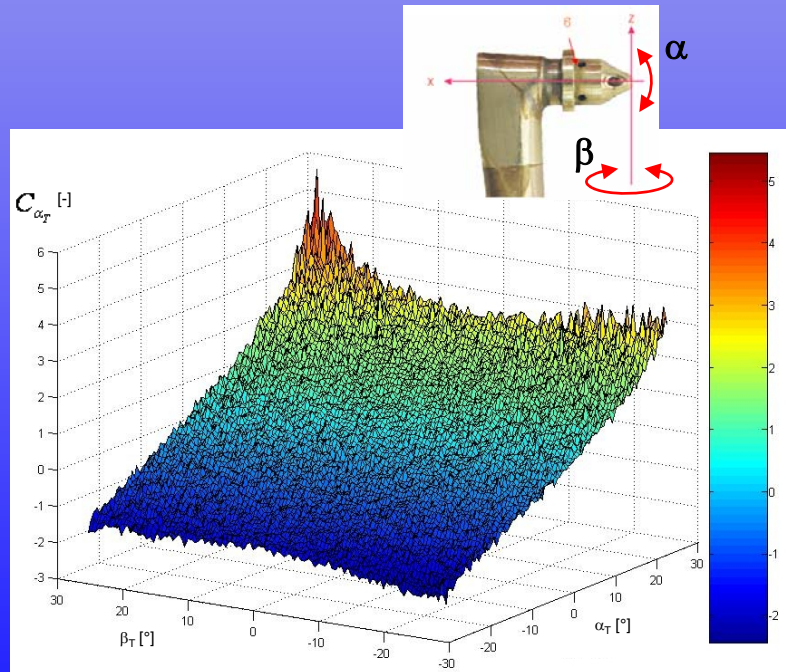
• Numerical CFD solver Ansys CFX-5

Diploma Thesis (contd.)

Direction Dependent Wind Speed Probes
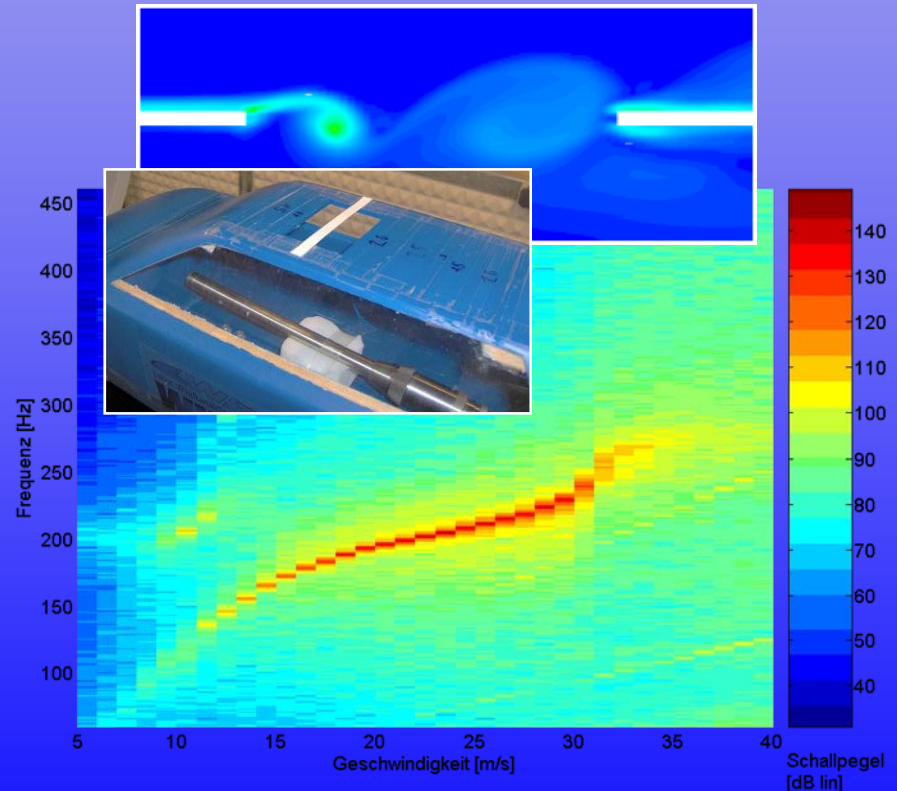
Christian Lackinger 09.04-02.05

- 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

Google.de: „Windkanal Strömungsmesstechnik"

http://www.fh-regensburg.de/fk/m/labore/562.php