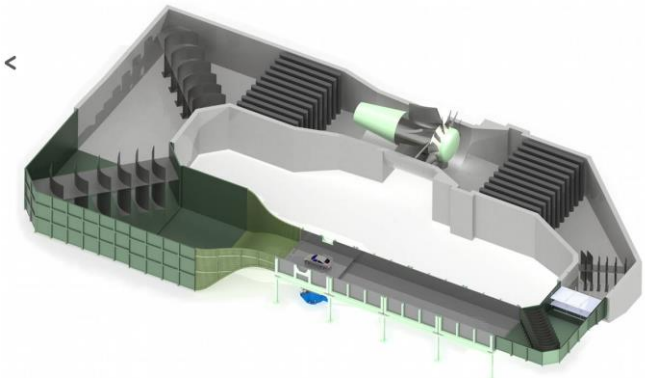
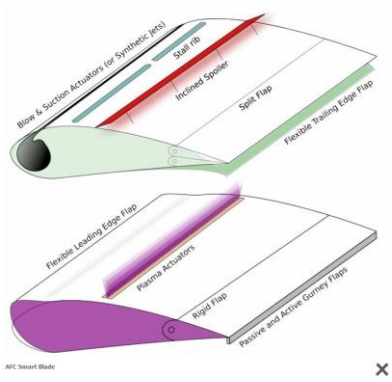
# Windtunnel and Towing Tank at the University of Berlin, Germany

## Description of facility

**Pictures:**






**General description: Large wind tunnel (GroWika)**

| | |
|---|---|
| Type: | Göttingen type wind tunnel |
| Size of test section: | low speed: 4.2m x 4.2m x ca. 4.0m (width x height x length)<br>high speed: 2.0m x 1.4m x ca. 4.0m |
| Configuration: | closed test section |
| Velocity range: | up to 8 m/s in low speed section<br>up to 60m/s in high speed section |
| Background Ti: | below 2.0 % in low speed section<br>below 0.5% in high speed section |
| Cooling: | no |
| Additional features: | Set-up for testing airfoil-sections at Re = 1 to 2 million<br>Set-up for testing model wind turbines, see below |

**General description: Towing tank**

Dimensions: Length = 250m, Width = 8.1m, Depth = 4.8m

Weight: ca. 20 t

Max. forces: 2000 kg (vertical), 1000 kg (horizontal)

Velocities: 0.125-12.5 m/s; 0.125-10.0 m/s (backwards)
max. Acceleration: 1.0 $m/s^2$
max. decceration: 3.0 m/s2

**Measurement equipment:**

Pressure:

- Prandtl tubes etc.
- 3 x pressure systems of around 50 to 60 channels each, including differential pressure sensors: 60 x 1000 Pa (max.), 30 x 2000 Pa and 30 x 5000 Pa
- Wake-rake including 60 pressure tubes.

Forces:

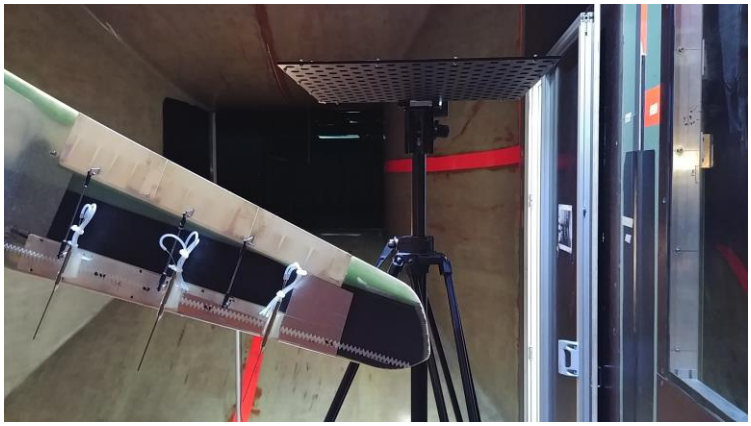
- 6 component force balance for static measurements underneath high speed section

Velocity:

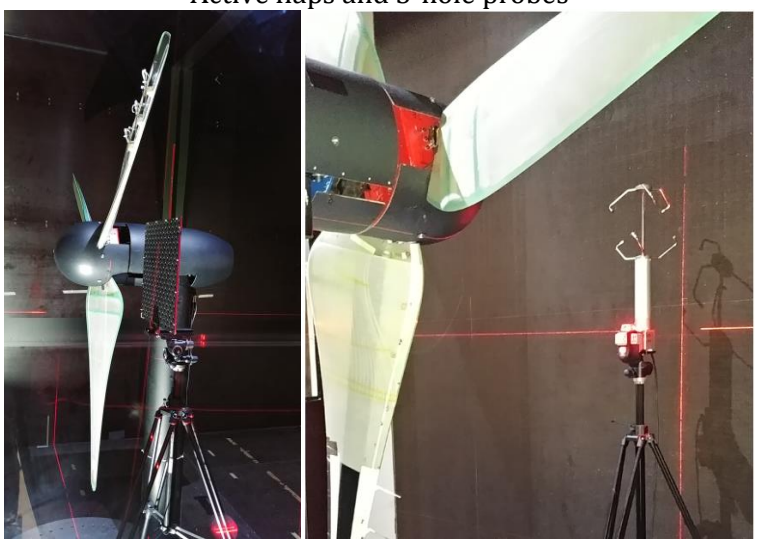
- hot-wire anemometry (X-wires)
- 2 x high energy Stereo Particle Image Velocimetry (PIV) + cameras
- 1 x high speed PIV + cameras
- 1 x Laser Doppler set-up
- 2 x 3D Ultrasonic Anemometers

**WEA Models:**

| | |
|---|---|
| Turbine name | BeRT (Berlin Research Turbine) |
| Main usage | Research |
| Turbine Type | 3- bladed HAWT |
| Rotor Diameter | 3m |
| Rated RPM and TSR | 180 rpm and 4.6 |
| Blade Profile | Clark-Y, t/c(max) = 12% |
| Blade Material and Manufacturing | Laminated with fiber glass reinforced epoxy, hollow |
| On-board Measurement Devices | RPM, azimuthal angle<br>Strain gauges (flapwise & edgewise root bending moments)<br>Pressure distribution at r=0.45R<br>AoA with 3-hole probes at r=0.65R, r=0.75R and r=0.85R<br>Power output |



Active flaps and 3-hole probes



PIV set-up (left), Inflow measurement with 3D Ultrasonic Anemometer (right)

| | |
|---|---|
| Turbine name | DIY (Self-built according the Hugh Piggott design) |
| Main use | Lectures |
| Turbine Type | 3- bladed HAWT |
| Rotor Diameter | 2m |
| Rated TSR | 7 |
| Blade Profile | NACA4412, t/c(max) = 12% |
| Blade Material and Manufacturing | Carved from wood |
| Drive | Self-built, permanently excited synchronous generator |
| On-board Measurement Devices | RPM, torque, power output |
| Future plans | 3D printed rotor blades |

**Inflow conditions:**

At the inlet plane:

- Velocity profile in axial direction
- Small velocity profile in vertical direction
- TI of around 1.5% using additional turbulence mats

**Related publications:**

Mueller-Vahl, H., Pechlivanoglou, G., Nayeri, C. N. and Paschereit, C. O.: Vortex Generators for Wind Turbine Blades: A combined Wind Tunnel and Wind Turbine Parametric Study, ASME Turbo Expo, GT2012-69197, https://doi.org/10.1115/GT2012-69197, 2012.

Klein, A. C., Bartholomay, S., Marten, D., Lutz, T., Pechlivanoglou, G., Nayeri, C. N., Paschereit, C. O., and Krämer, E.: About the suitability of different numerical methods to reproduce model wind turbine measurements in a wind tunnel with a high blockage ratio, Wind Energy Science, https://doi.org/10.5194/wes-3-439-2018, 2018.

Soto-Valle, R., Bartholomay, S., Alber, J., Manolesos, M., Nayeri, C. N. and Paschereit, C. O.: Determining the Angle of Attack along a Wind Turbine Rotor Blade in Wind Tunnel Experiments, Wind Energy Science, https://doi.org/10.5194/wes-2020-35, in review, 2020.

Alber, J., Soto-Valle, R., Manolesos, M., Bartholomay, S., Nayeri, C. N., Schönlau, M., Menzel, C., Paschereit, C. O., Twele, J., and Fortmann, J.: Aerodynamic Effects of Gurney Flaps on the Rotor Blades of a Research Wind Turbine, Wind Energ. Sci. Discuss., https://doi.org/10.5194/wes-2020-40, in review, 2020.

**Website:**

**http://fd.tu-berlin.de/en/**
**http://fd.tu-berlin.de/en/research/wind-energy/**

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