Category: 5

Measurement of turbine inflow with a 3D WindScanner system and a SpinnerLidar

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1. Motivation

1.1 Current practice: free wind speed

Wind turbine power performance measurement are based on the relation between the free wind speed, i.e. the wind speed at the turbine location if there were no turbine, and the turbine response in terms of power or loads. Practically, this requires measuring the wind speed upstream of the induction zone of the turbine. However, as the size of wind turbines is increasing, the measurements need to be taken several hundreds of meters away from the turbine. The correlation between the wind measured upstream and the wind at the turbine location is therefore decreasing, especially for turbines installed in complex terrain.

1.2 New approach: inflow measurement

The UniTTe (Unified Turbine Testing) project (www.UniTTe.dk) aims at developing new procedures for power curve and loads assessment based on wind measurements taken closer to the rotor plane – therefore inside the induction zone – in order to increase this correlation.

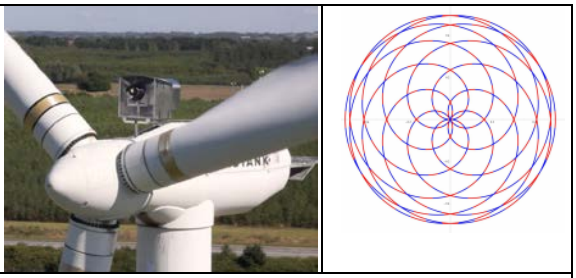

Fig. 1 Left: Picture of the SpinnerLidar on the turbine nacelle; Right: Scan pattern

2. Measurement set up

This paper is presenting the first measurement campaign of UniTTe. Detailed measurement of the inflow, in front of the 550 kW Nordtank wind turbine (rotor diameter D=40m), at the DTU Risø Campus, have been taken simultaneously with the short-range WindScanner system (www.WindScanner.dk) and the SpinnerLidar [1].

2.1 The short-range WindScanner system

Three time and space synchronized short-range WindScanners were deployed around the turbine to measure the wind velocity vectors in 3 dimensions, along scan trajectories laid out in 3 different planes of 1D by 1.5D, with a spatial resolution of 4m. The measurements were validated against a sonic anemometer mounted on a mast, at 30 m a.g.l.

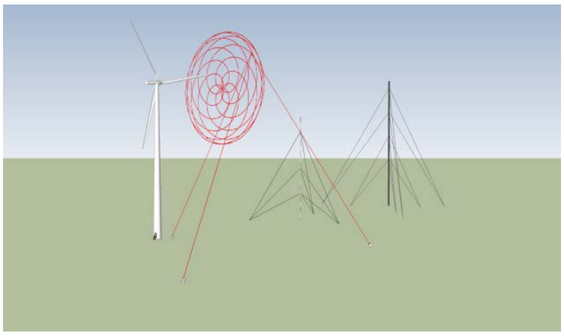

Fig. 2 Measurement set up with the three WindScanner systems around the turbine and the upstream masts

2.2 The SpinnerLidar

The SpinnerLidar, originally designed for spinner-integration, was installed on the top of the turbine nacelle, behind the rotor, and set to scan at 46 m upstream. With its two rotating scan prisms, the SpinnerLidar is able to scan the entire swept rotor area in a few seconds (see scanning pattern to the right in Figure 1) and thus provided measurements with a very high spatial and temporal resolution.

3. Outcome

This is a unique measurement campaign, combining the SpinnerLidar and the short-range WindScanner system. The measurements have been inter-compared with standard anemometry, which will demonstrate the benefits of these new remote sensing wind measurement technologies.

4. References

[1] Sjöholm et al. Full two-dimensional rotor plane inflow measurements by a spinner-integrated wind lidar, EWEA2013