

High Resolution Wind Turbine Wake Measurements with a Scanning Lidar

T. Herges¹, B. Naughton¹, D. Maniaci¹, T. Mikkelsen², M. Sjöholm²

¹Sandia National Laboratories, Albuquerque, NM, 87185, therges@sandia.gov

²DTU Wind Energy, Risø Campus, Roskilde, Denmark, tomi@dtu.dk

ABSTRACT

A team of researchers at Sandia National Laboratories (SNL) conducted a field experiment at the DOE Scaled Wind Farm Technology (SWiFT) facility [1] to characterize wake dynamics. Data collected as part of the multi-month field campaign will be used to improve understanding of wind turbine wake phenomena. Additionally, this data will undergo extensive uncertainty quantification (UQ) for the purpose of future formal verification and validation of high-fidelity wind plant simulation models. In order to address the challenge of collecting high-quality, high-resolution data, the team partnered with the DTU Wind Energy Department to leverage their wake measurement expertise and their custom-built SpinnerLidar, which is uniquely capable of measuring at the temporal and spatial resolution required for the experiment at SWiFT [2]. Fig. 1a displays an image of the SpinnerLidar installed in the WTG1 SWiFT turbine, which is a heavily modified Vestas V27.

The present work will concentrate on the analysis of high-quality SpinnerLidar data acquired at the SWiFT site to improve understanding of the wind turbine wake as a function of the atmospheric boundary layer inflow. A sample velocity (v_{LOS}) trace is presented in Fig. 1b. The measurements were acquired at 3D ($D = 27$ m) downstream of the turbine, and the red dots indicate the measurements locations (with bad points removed), while the white line outlines the wake. This sample measurement shows the rotated/stretched wake shape created during a stable boundary layer with a larger amount of positive veer. In the final paper, the wake characteristics will be quantified under a range of atmospheric conditions.

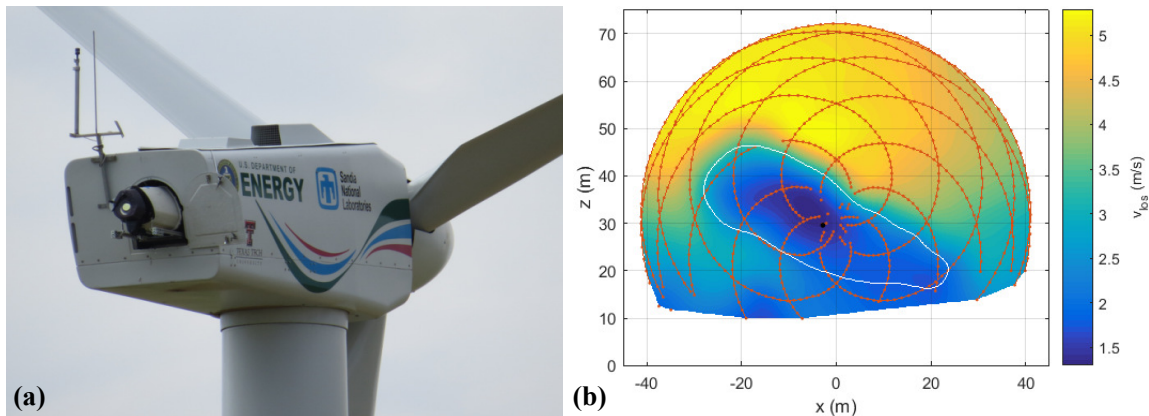


Figure 1: (a) DTU SpinnerLidar installed in SWiFT turbine and (b) v_{LOS} of SWiFT wind turbine wake for a stable atmospheric boundary layer with large positive veer at 3D downstream (orientation: standing downstream, looking upstream at wind turbine).

REFERENCES

- [1] Kelley, C. L., and Ennis, B. L. "SWiFT Site Atmospheric Characterization," *SAND2016-2016*. Sandia National Laboratories (2016).
- [2] Machefaux, E., Larsen, G. C., Troldborg, N., Hansen, K. S., Angelou, N., Mikkelsen, T., and Mann, J. "Investigation of wake interaction using full-scale lidar measurements and large eddy simulation," *Wind Energy* Vol. 19, Issue 8, (2016) pp 1535-1551. DOI: 10.1002/we.1936.