WIND FIELD RECONSTRUCTION WITH OFFSHORE NACELLE-MOUNTED LIDAR MEASUREMENTS

Rebeca Marini[1], Konstantinos Vratsinis[1], Cédric Peeters[1], Jan Helsen[1]

[1]Vrije Universiteit Brussel

MOTIVATION

- **Why?** To further encourage the construction of offshore wind farms.

  - Important to reduce the levelized cost of energy and increase the annual energy production.

- **Solution?** An accurate wind field reconstruction (WFR) can be used for further improving the wind turbine's control.

- **How?** The WFR can be created with the use of LIDAR measurements, either ground- or nacelle-mounted.

OWI-LAB photo of a North-Sea wind farm (BE).

LIDAR MEASUREMENTS

LIDAR MEASUREMENTS
NACELLE MOUNTED LIDAR

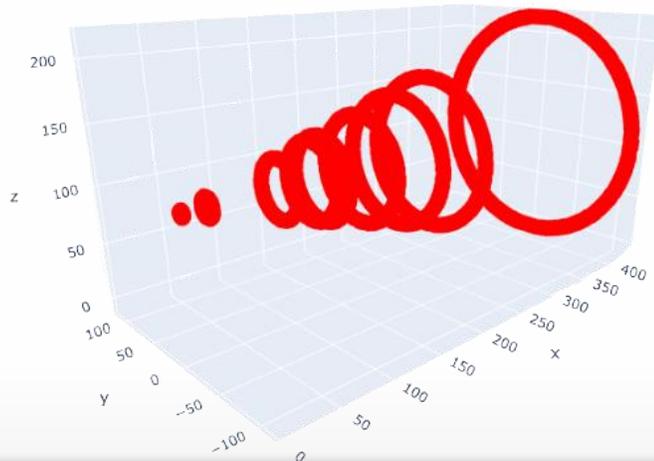
OWI-LAB photo nacelle-mounted LiDAR.

- **What is it?** The LiDAR is a remote sensor instrument capable of sampling the wind by means of infra-red laser beams.

  - **Proved usability** in wind speed, wind direction and turbulence profiling, power curve assessment, wind resource assessment.

- A 50Hz continuous-wave nacelle-mounted LiDAR from ZX Lidars.

- Less expensive instrumentation, when compared to meteorological masts.
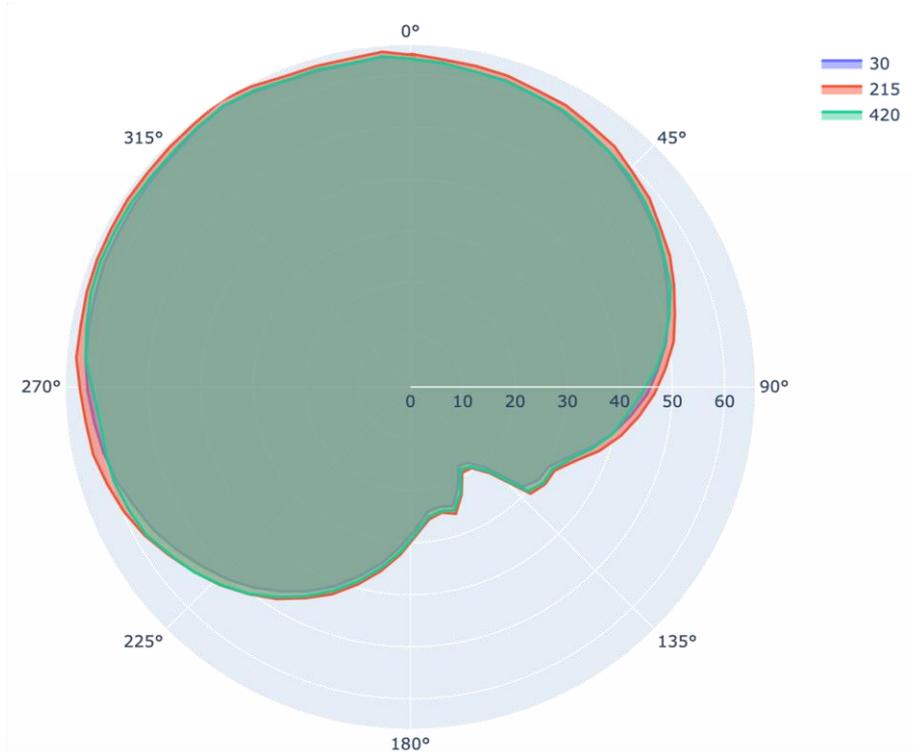
VRIJE
UNIVERSITEIT
BRUSSEL

LIDAR PERFORMANCE ANALYSIS

- **Analyse the data:** Mean, standard deviation, and skewness. Also, through histograms, time series plots, and wind rose diagrams, to visualize the wind data in different ways.

- Validate position of the lidar and control the quality of the measurements.

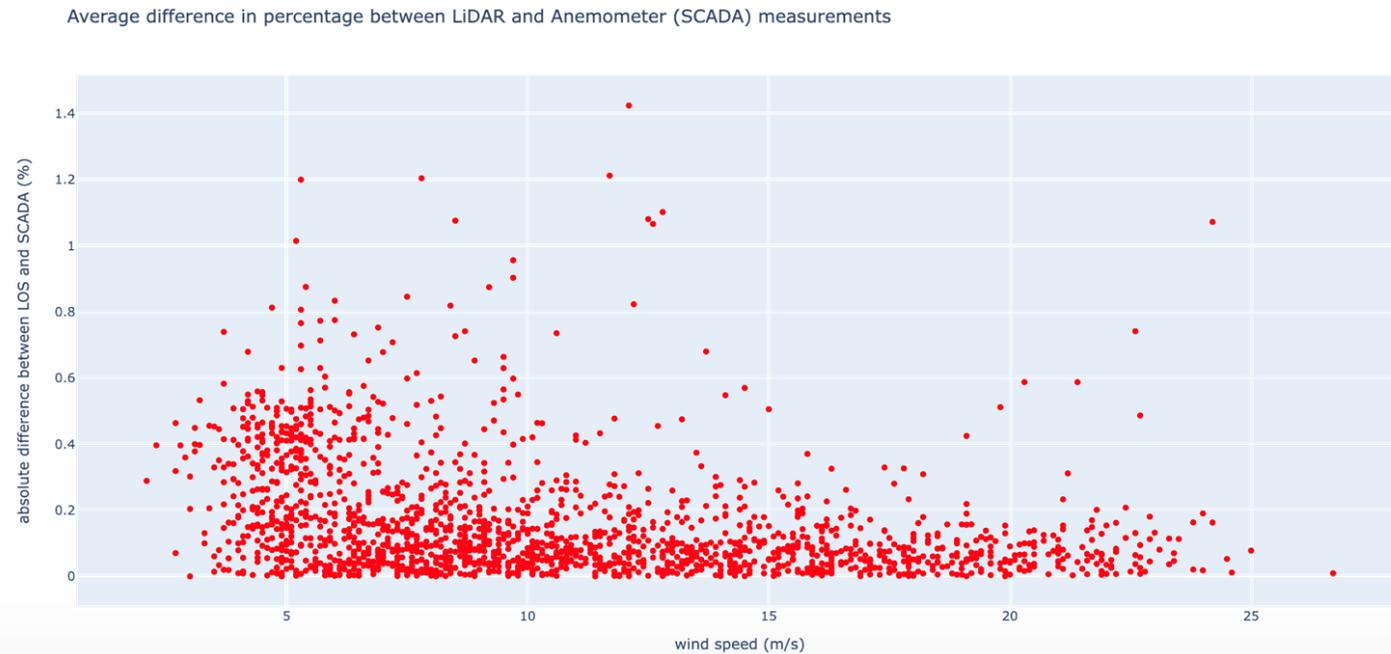Measurement's location along different distances of the wind turbine

Percentage of valid data along different ranges of measurement

LIDAR MEASUREMENTS

COMPARISON WITH SCADA ANEMOMETER

- **Compare the data:** Compare the lidar data with other data sources, such as weather station data or the scada anemometer.
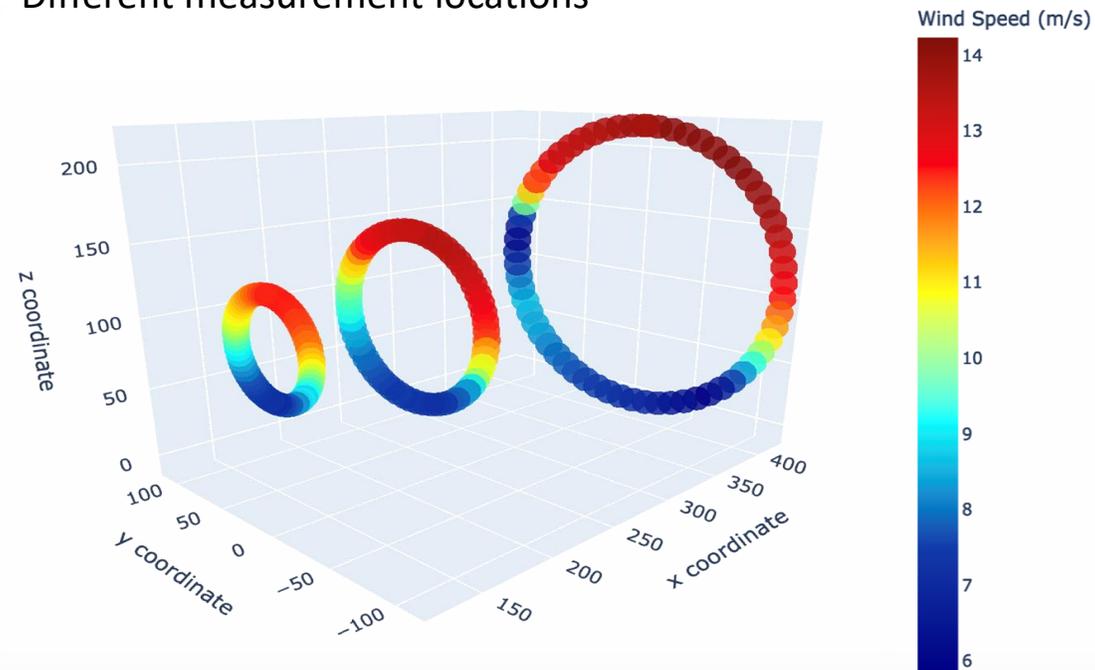
Average difference in percentage between LiDAR and Anemometer (SCADA) measurements

WIND FIELD RECONSTRUCTION

LIDAR MEASUREMENTS

- LiDAR measurements do not directly calculate the wind parameters.
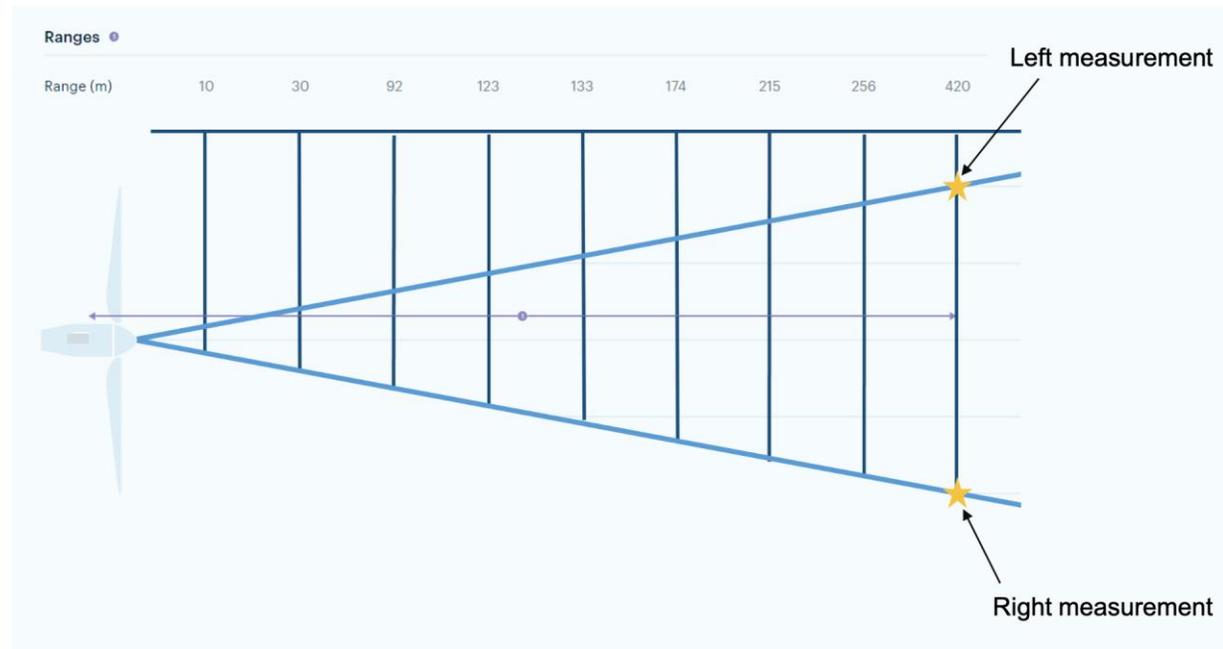

Different measurement locations

2-BEAM RECONSTRUCTION

- 2-Beam reconstruction applied as in **[1]:**

$$u_x = (LLOS + RLOS)/(2cos\phi) \; ; \; u_y = (LLOS - RLOS)/(2cos\phi) \; ; \; \theta = arctan2(u_x, u_y)$$
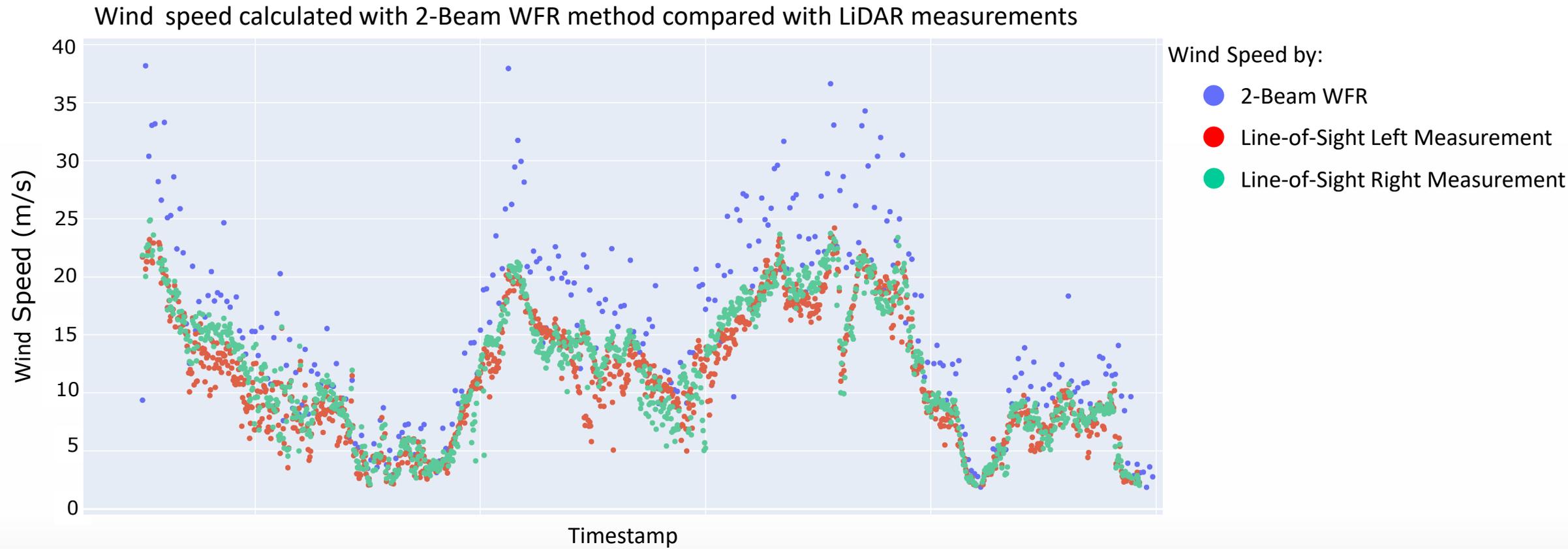
[1] R. Wagner, T.F. Pedersen, M. Courtney, I. Antoniou, S. Davoust, and R.L. Rivera. Power curve measurement with a nacelle mounted lidar. *Wind Energy*, 17(9):1441–1453, 2014.

VRIJE
UNIVERSITEIT
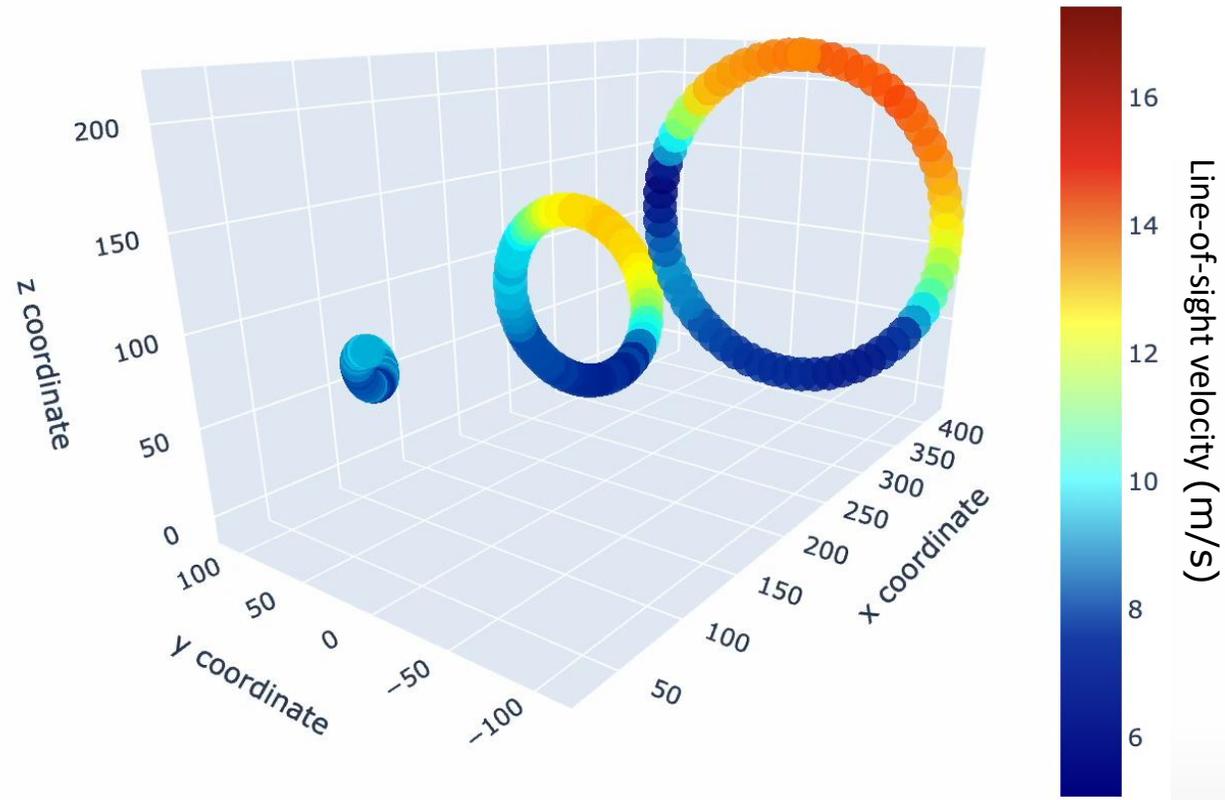BRUSSEL

RESULTS

Wind speed calculated with 2-Beam WFR method compared with LiDAR measurements

LiDAR measurements along ranges upstream wind turbine

- LiDAR can be used as an equally efficient and less expensive instrumentation compared with a met-mast.

- It is necessary to use wind field reconstruction methods in order to obtain wind parameters.

- The 2-Beam reconstruction method is a widely used method.

- More complex methods have been proven in the literature to calculate more accurate wind parameters.

- The more accurate these parameters, the better the wind field can be reconstructed and used for wind turbine control.

VRIJE
UNIVERSITEIT
BRUSSEL

THANK YOU

rebeca.marini@vub.be
+32 494 93 86 83

VRIJE
UNIVERSITEIT
BRUSSEL