

Measurements of the induction zone, wind turbine wake and free flow in the complex and forested terrain with the hybrid WindScanner system

Funded by three projects (UniTTE, FarmOpt and the New European Wind Atlas (NEWA)) a large flow field experiment, the Perdigão experiment, with two multi-lidar systems in the complex and forested terrain of Serra do Perdigão in Portugal will take place during the months of May and June 2015. The Perdigão experiment is going to be conducted with the participation of several European partners, namely Technical University of Denmark – Department for Wind Energy (DTU Wind Energy), Instituto de Ciência e Inovação em Engenharia Mecânica e Engenharia Industrial (INEGI), Laboratório Nacional de Energia e Geologia (LNEG), Faculdade de Engenharia da Universidade do Porto (UPORTO), and Instituto Politécnico de Bragança (IPB).

The Perdigão experiment is an opportunity to deploy and benefit of the simultaneous operation of both short-range and long-range WindScanner systems (i.e. hybrid WindScanner system). Each system consists of three spatially separated scanning lidars controlled or coordinated by the remote master computer.

The short-range WindScanner system's lidars have a small probe length within the operational range which maximum is 200 m. The maximum measurement rate is 400 Hz. Due to the limitation of the Continuous-Wave (CW) technology on which the lidars are based the lidars can only acquire single radial velocity at any measurement rate. Typically, the short-range WindScanner system is applied to perform small-scale measurements of 3D wind fields, with a particular scope on velocity field in front of and behind a wind turbine rotor.

On the other hand, the long-range WindScanner system's lidars have a range of up to 8000 m and the maximum measurement rate of 10 Hz during which they can simultaneously acquire radial velocity from 500 different range gates. The lidars are based on the pulsed technology and thus they have larger probe length in comparison to the short-range WindScanners. The long-range WindScanner system is suitable to acquire the mean flow features in a large number of points of interest within the large volume of the atmosphere.

The flow measurements with the hybrid system made in many points of interest and within the large volume of the atmosphere will be used to investigate:

- Induction zone in complex terrain of the single wind turbine at the hill top
- Wake of the single wind turbine in complex terrain
- Other features of the flow in complex and forested terrain (e.g. recirculation zone, speed-up effect)

For the first time the only two existing synchronized multi-lidar systems based on two different lidar technologies will be used at the same time. This means that the pilot Perdigão experiment will be the most technological advanced lidar based flow field experiment to date.

Beside the investigation of the different flow phenomena and technologically advancing flow field measurements, the experiment represents the opportunity for:

- Start developing the permanent setup for the future Perdigão experiment related to the New European Wind Atlas (NEWA) scheduled for 2017
- Increase experience and disseminate knowledge in operating field campaigns with WindScanners to partners involved in the experiment
- Develop the prototype data access facilitation and e-Science platforms based on the experimental data
- Develop the WindScanner.EU database of the Perdigão experiment

The last two points are elements of utmost importance in the future WindScanner.EU research infrastructure.