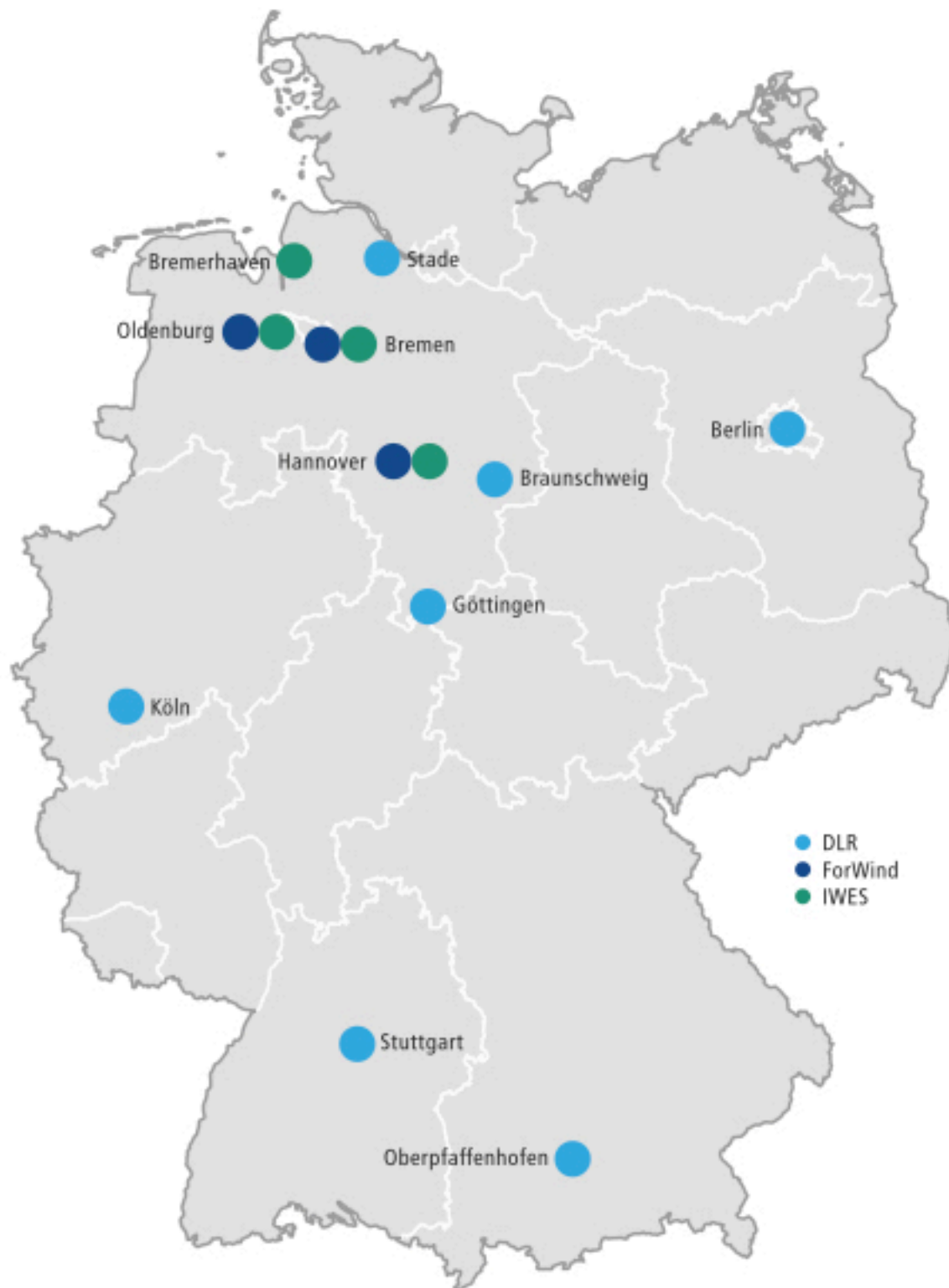

From turbulence to torque – why wind energy needs pre-competitive research and large research infrastructures

Dr. Stephan Barth

RPG2017 | 19 - 20 October 2017 | Wuhan, China



German Research Alliance Wind Energy



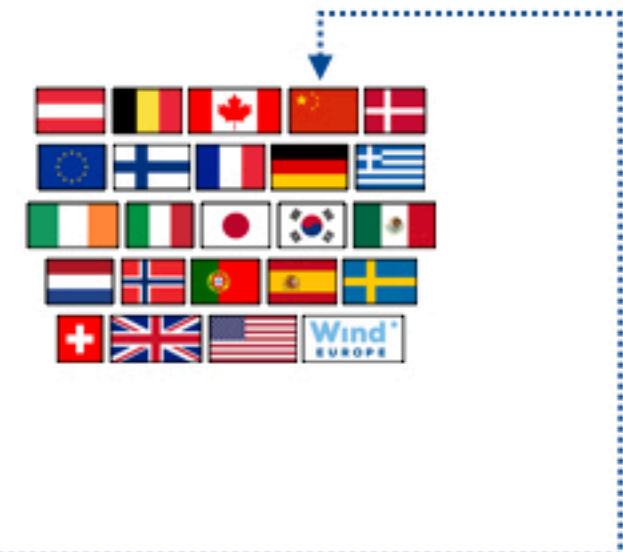
Research Alliance Wind Energy



More than 600 wind energy scientists and engineers.

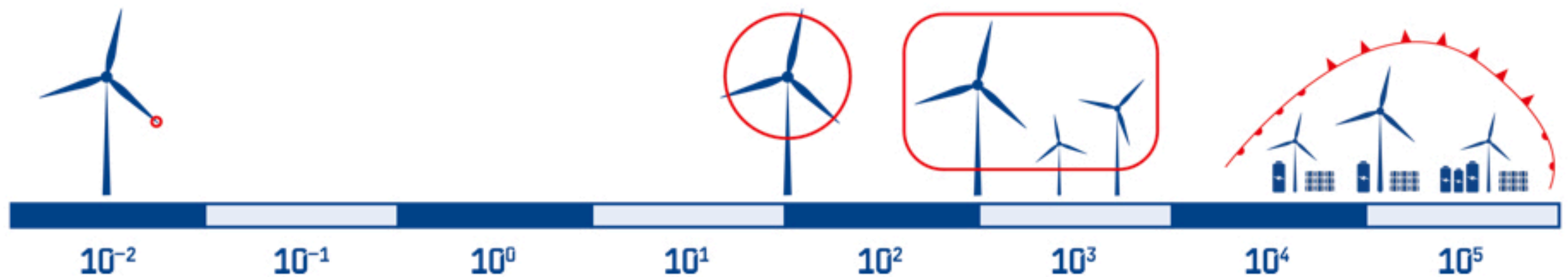
Operating large world class wind energy research infrastructures.

International collaborations in wind energy research



- Base Technology Information Exchange
- Wind Energy in Cold Climates
- Design and Operation of Power Systems with Large Amounts of Wind Power
- Small Wind Turbines in High Turbulence Sites
- Analysis of Wind Tunnel Measurements and Improvement of Aerodynamic Models
- Offshore Code Comparison
- Benchmarking of Wind Farm Flow Models
- Lidar Systems for Wind Energy Deployment
- Forecasting for Wind Energy

Why is it so challenging to combine research and knowledge?

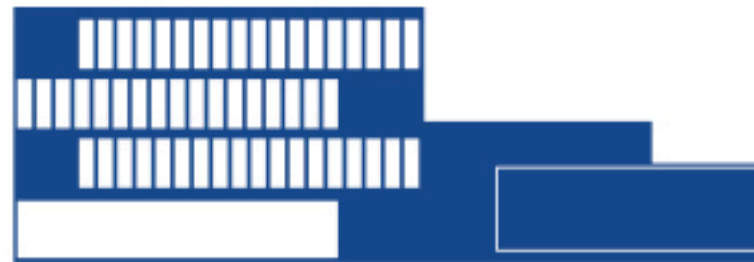


Simulation



High-Performance-Computing

Experiment



Large-scale Laboratories

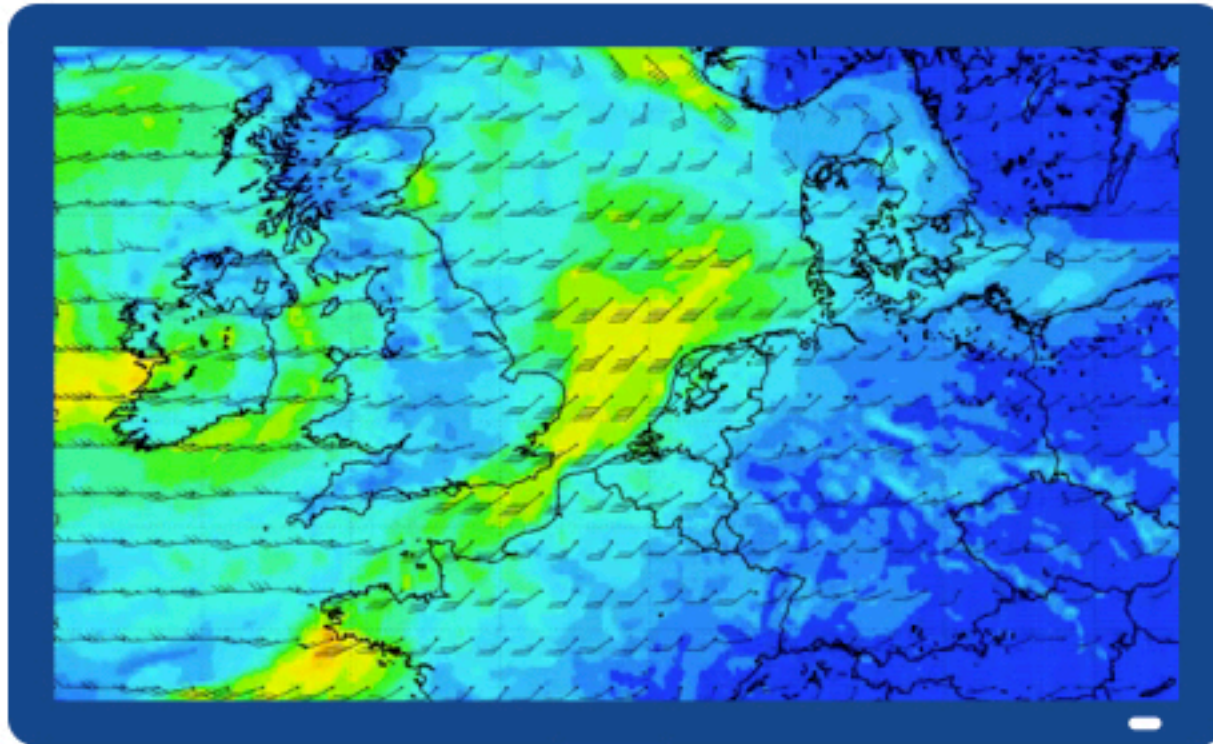
in situ



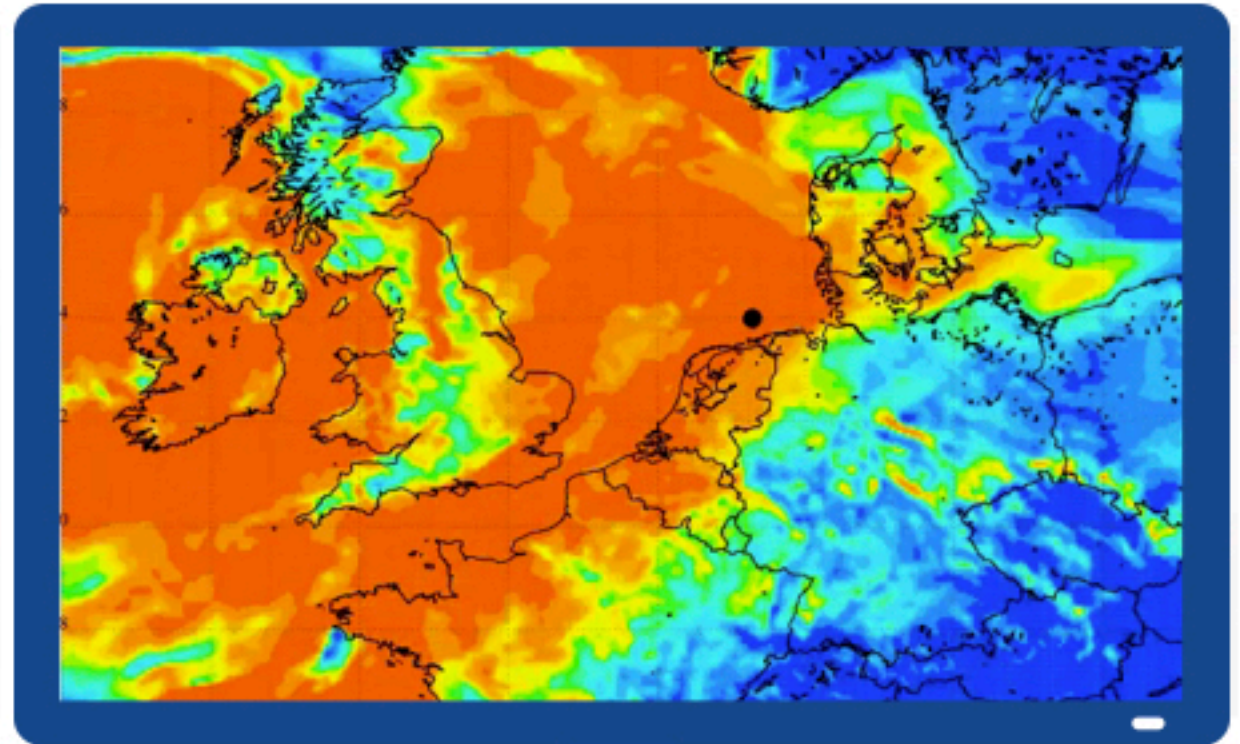
Open Air Test Sites

Extreme wind situations, e.g. cyclone Kyrill (01/2007)

wind speed

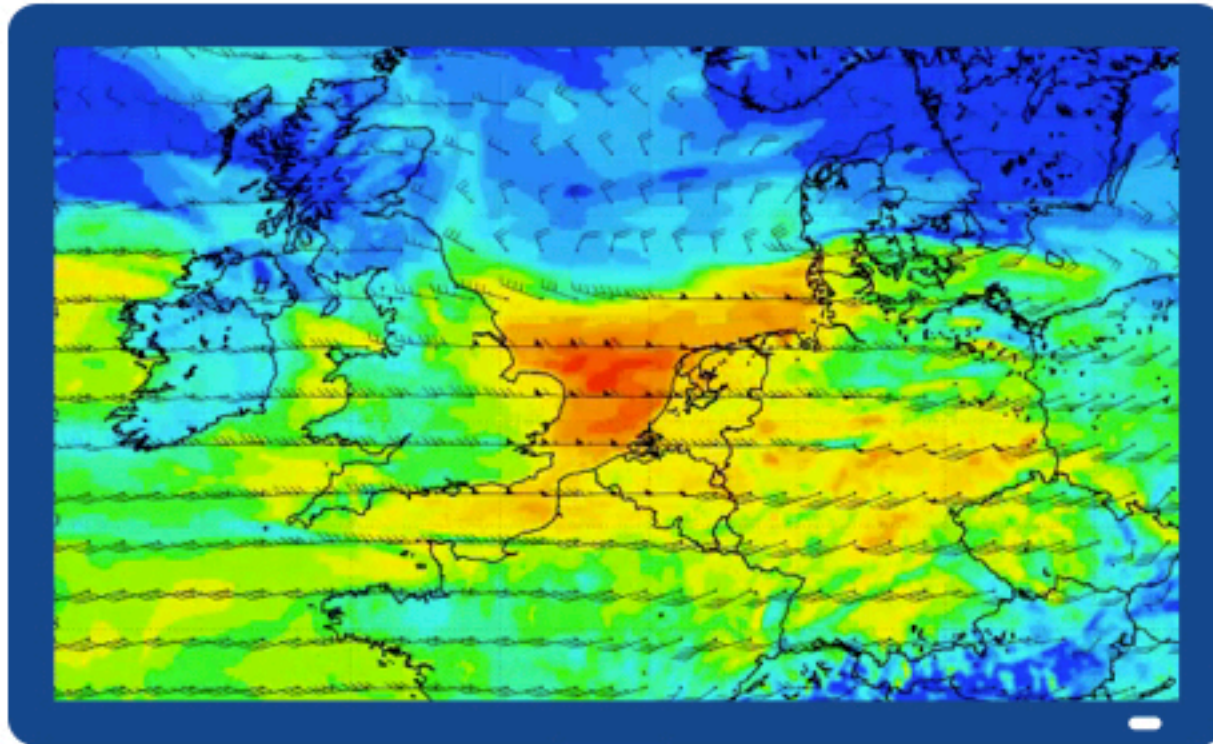


wind power

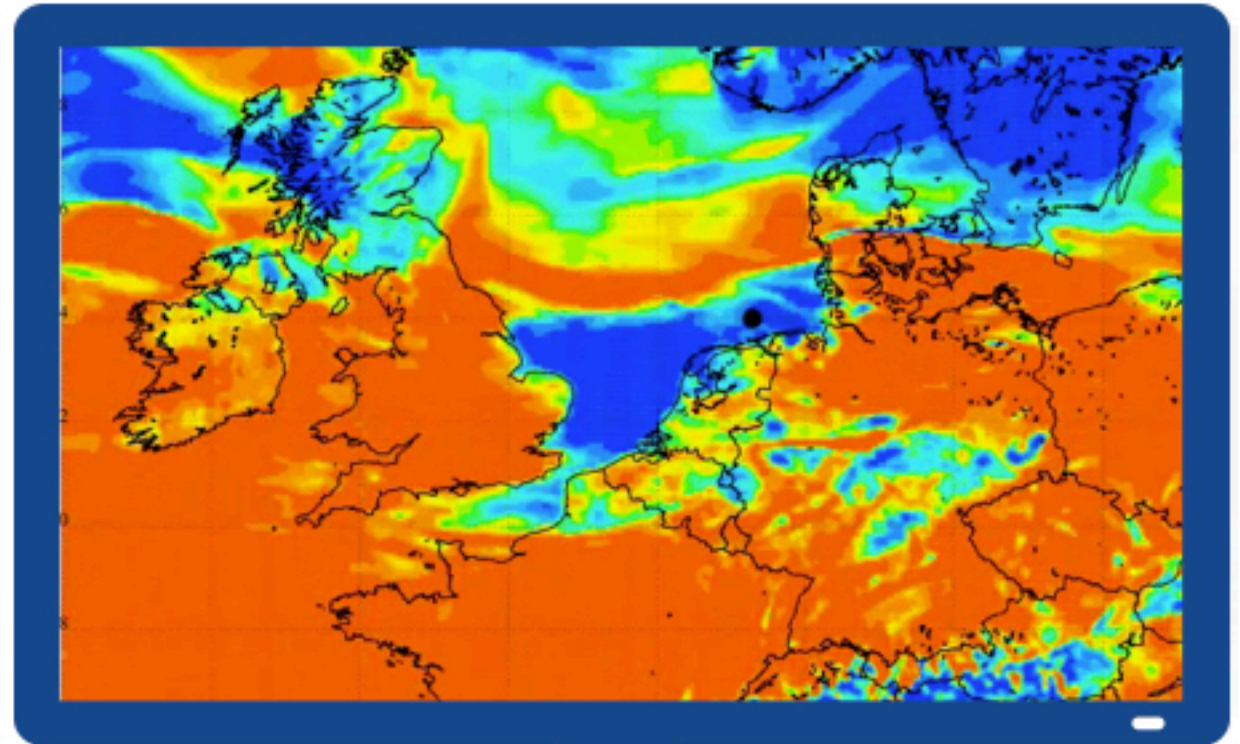


Extreme wind situations, e.g. cyclone Kyrill (01/2007)

wind speed

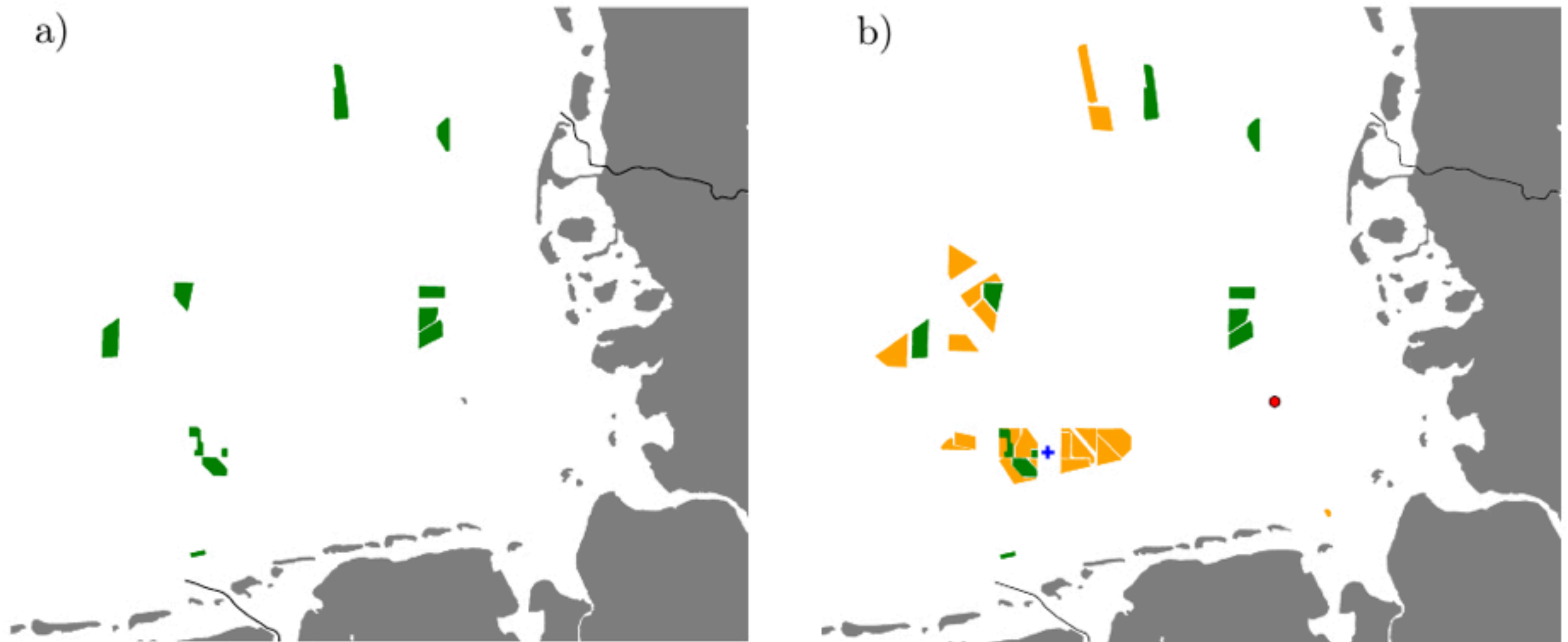


wind power



Offshore wind in German Bight

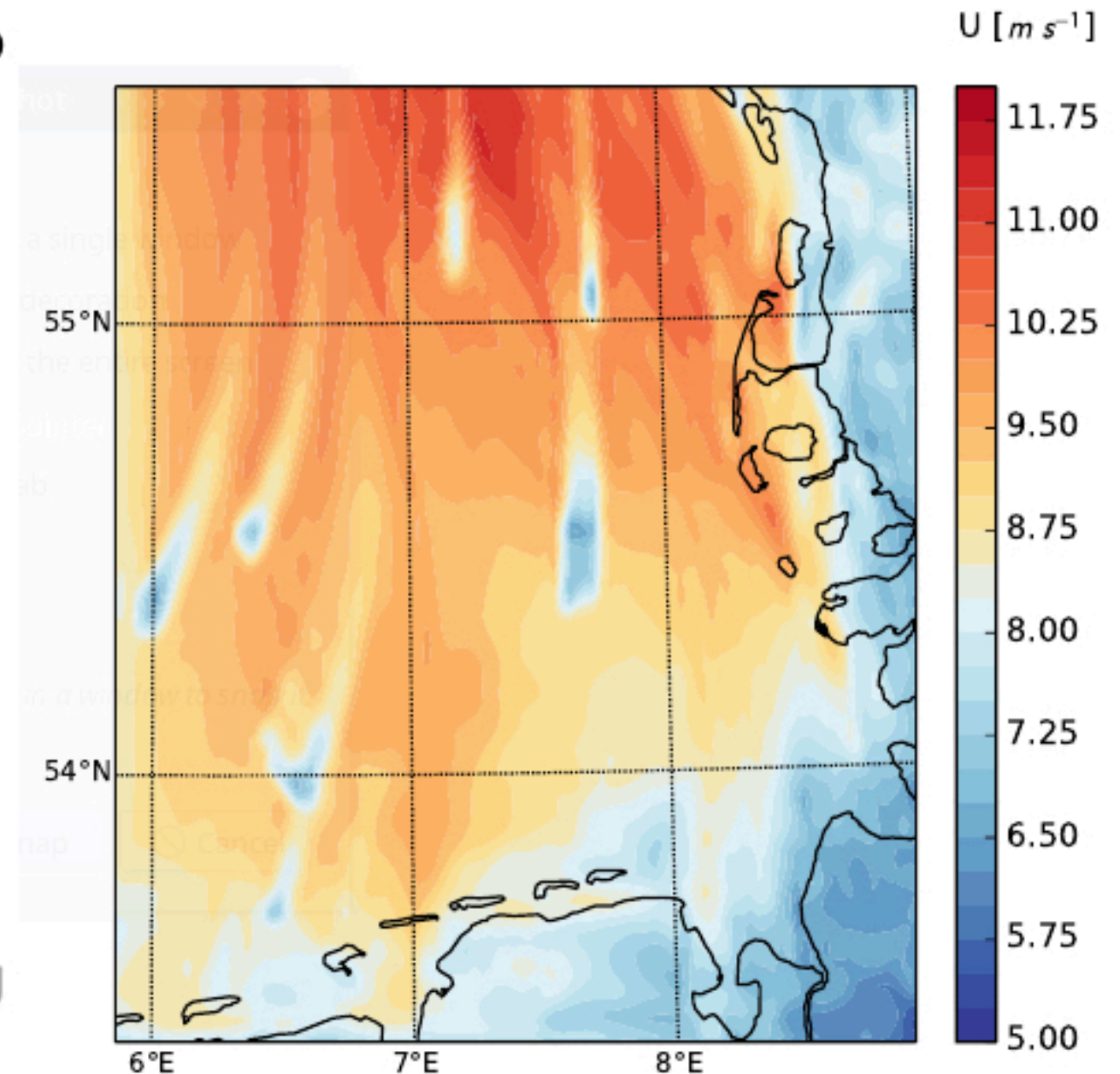
REF (0 WECs, 0 GW) SC1 (12/2015, 688 WECs, 2.9 GW) SC2 (12/2017, 1930 WECs, 9.3 GW)



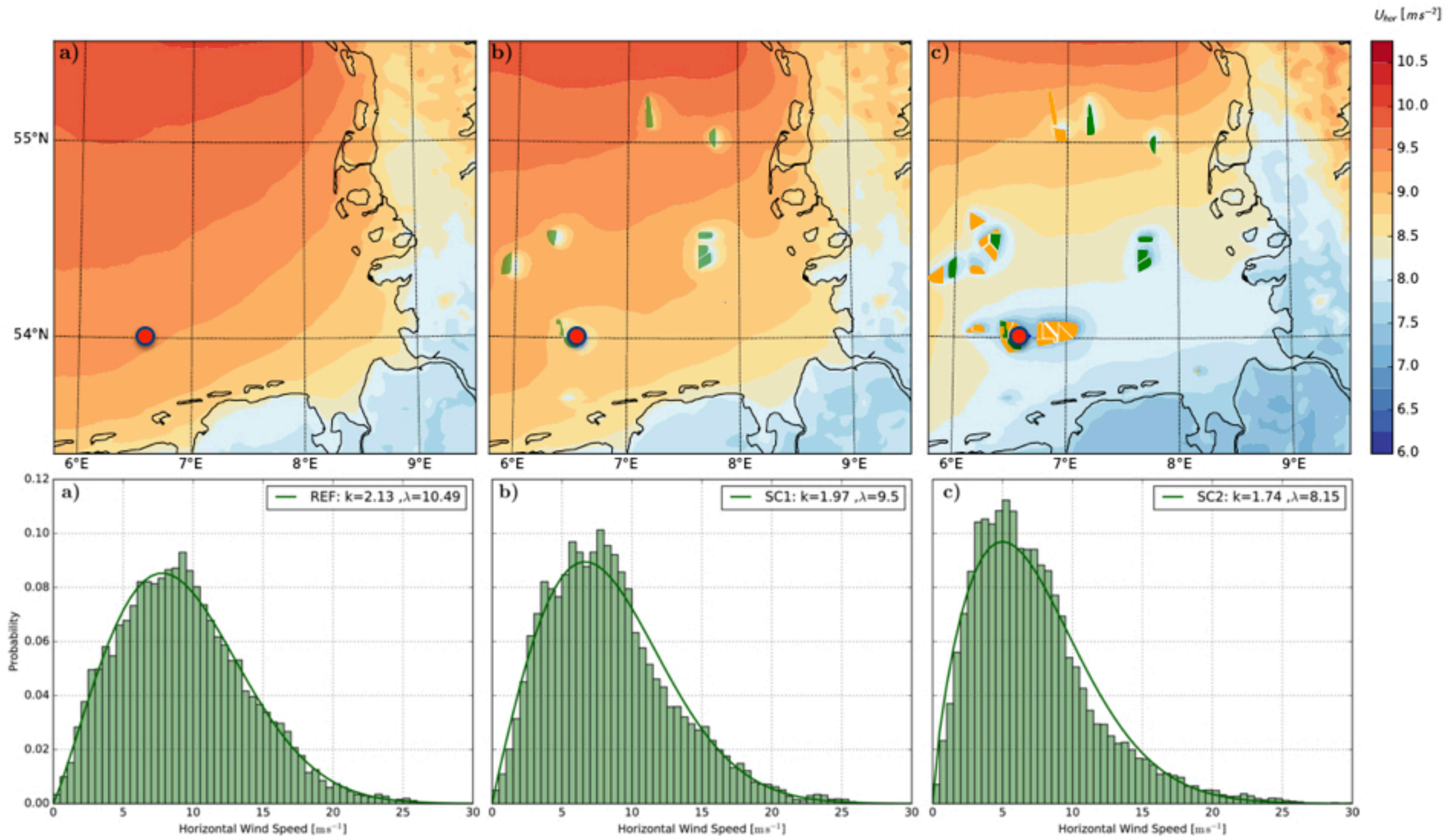
Fluctuating wind fields

- Mesoscale modelling strategy allows to look at time instances as well
- Coriolis force (and even the change of the Coriolis force) have a strong impact on the wind field in these large scales
- Engineering models for the simulation of large scale wind farm cluster wakes do need to account for this!

Instantaneous wind field at hub height (SC1) on 28.10.2011 – 03:00 UTC during southwesterly winds

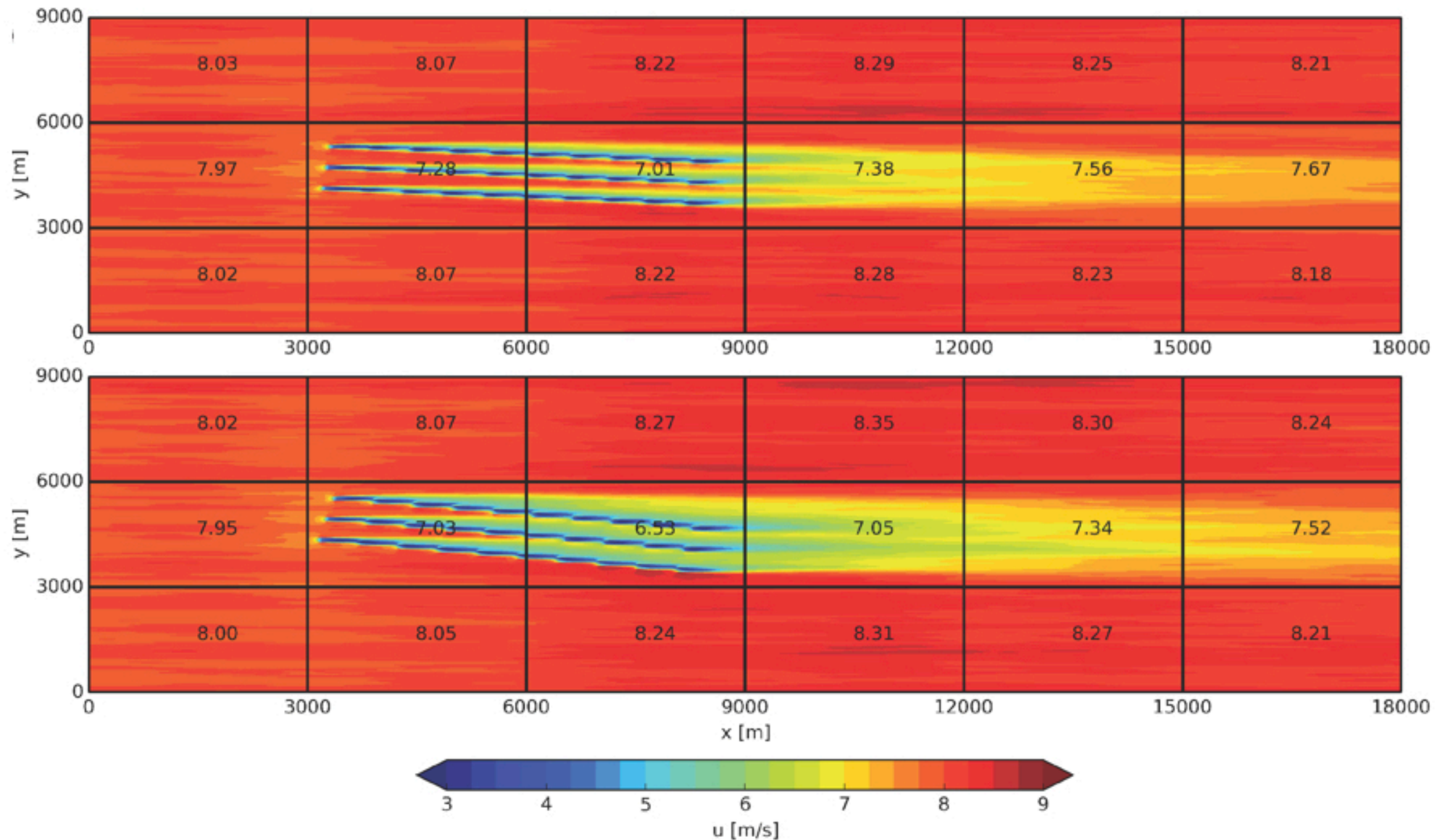


Reduction of average wind speed due to wind farms

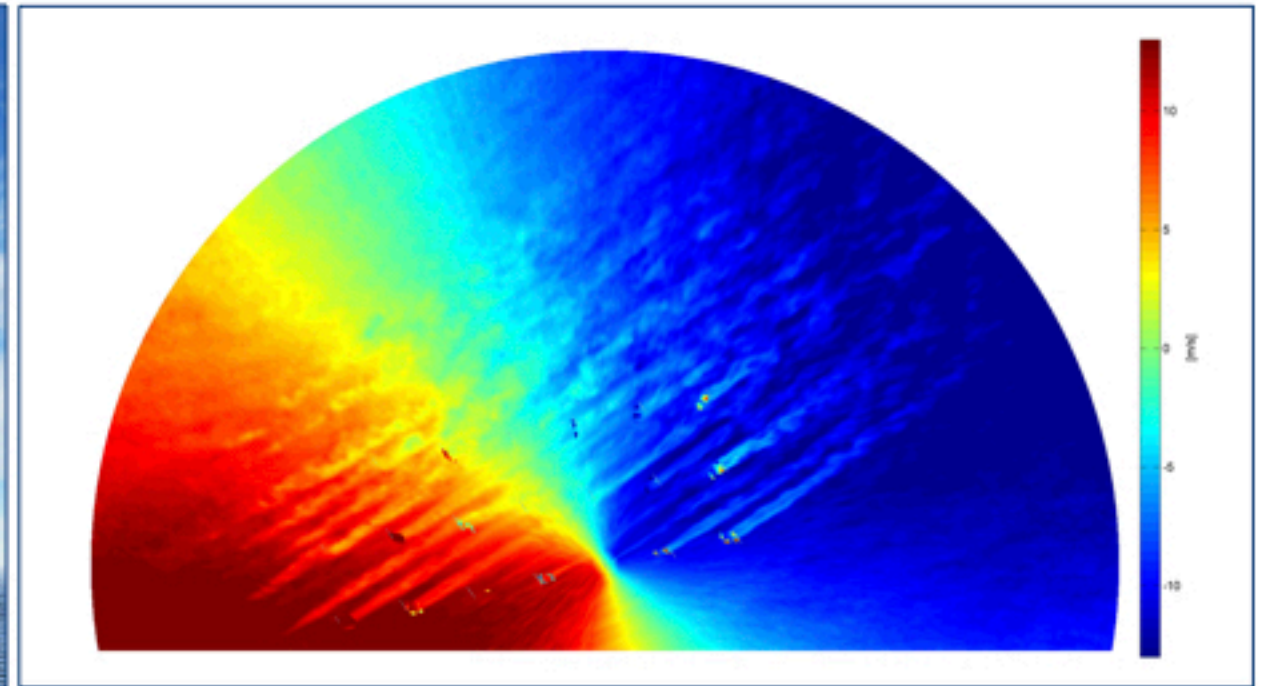
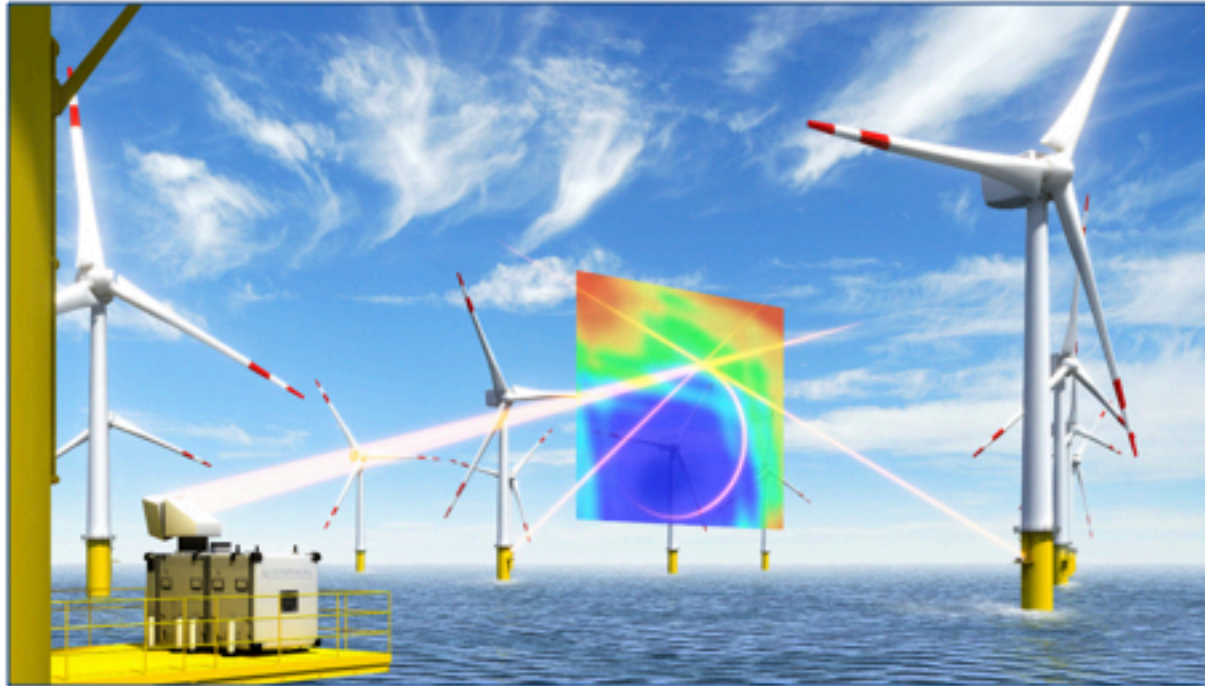
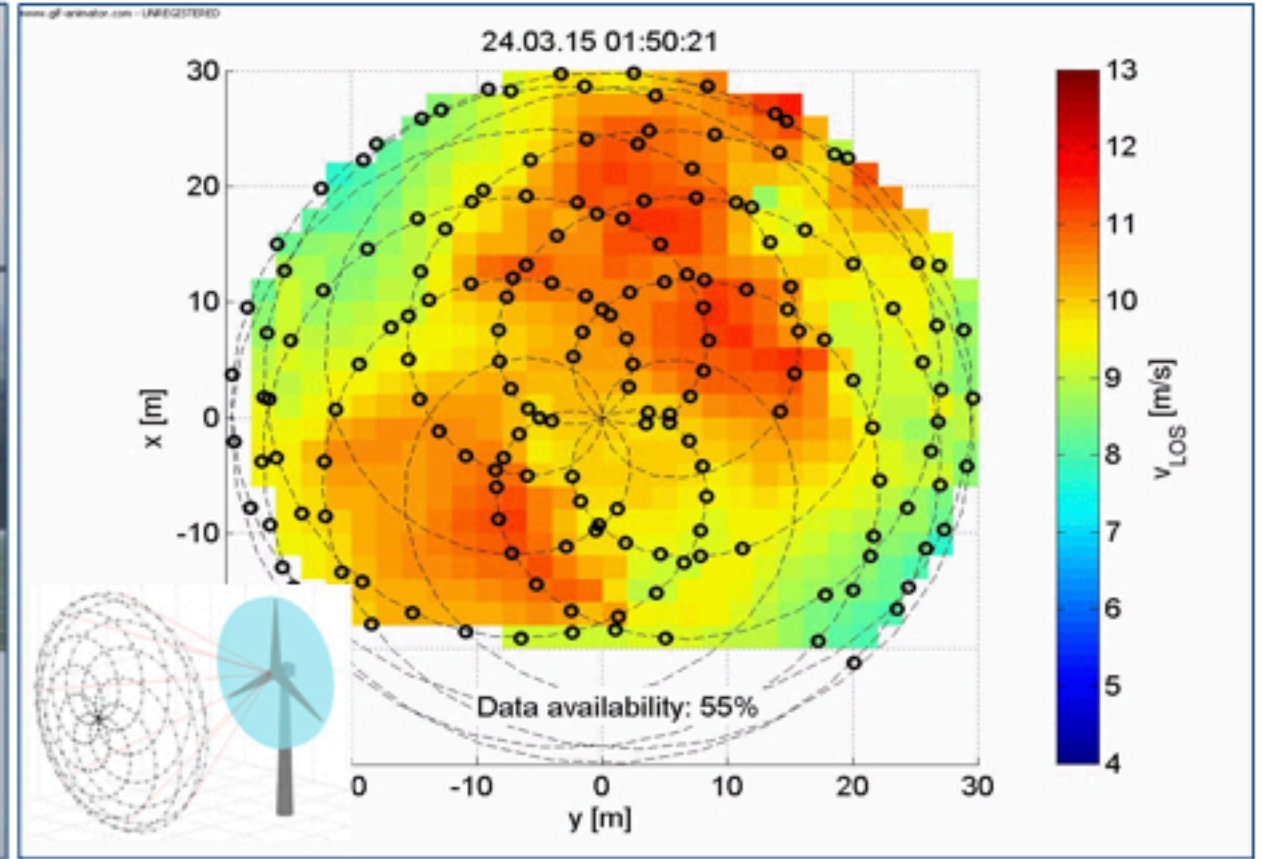
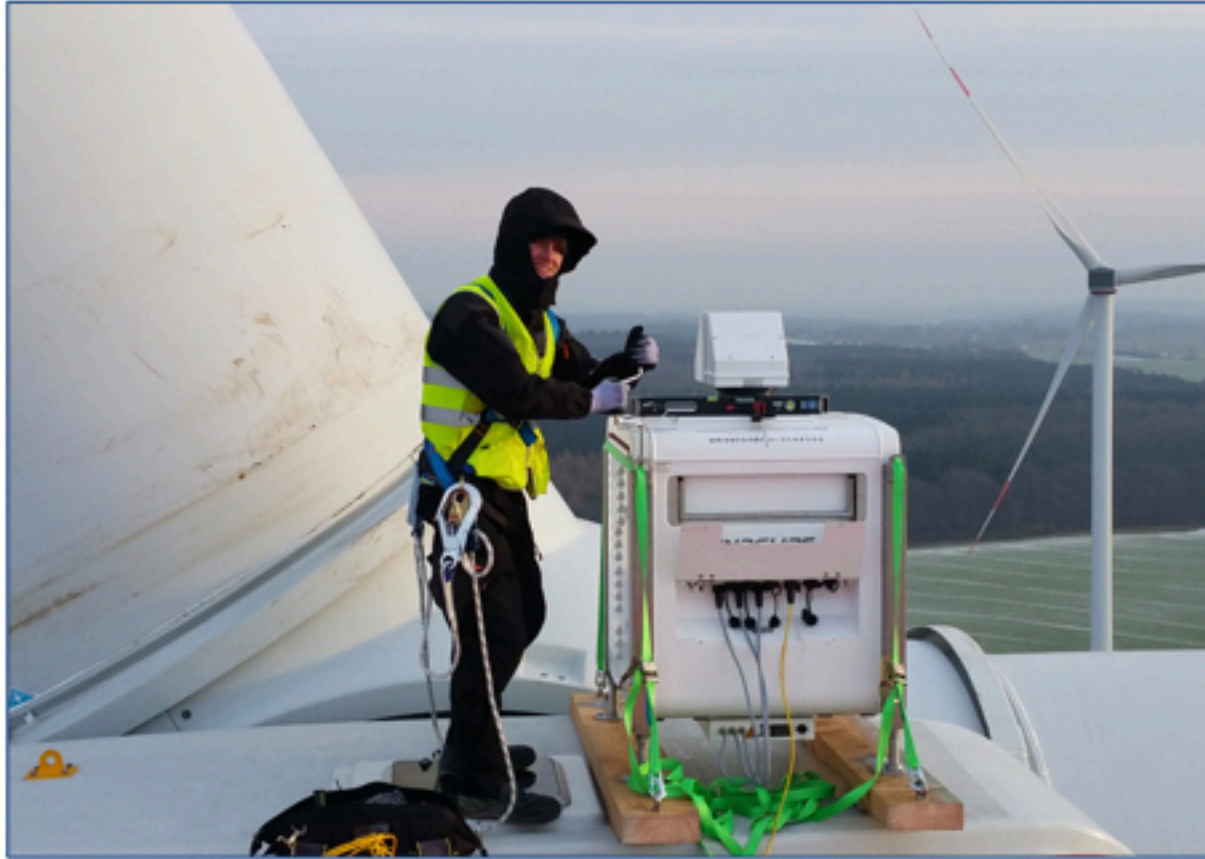


Limitations

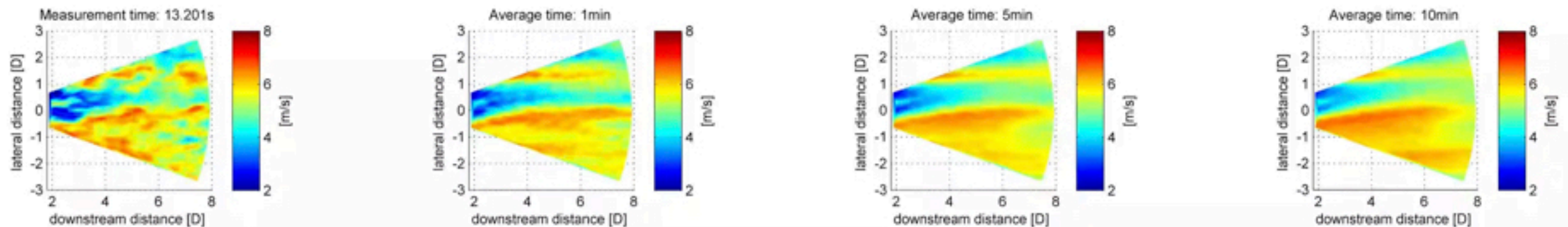
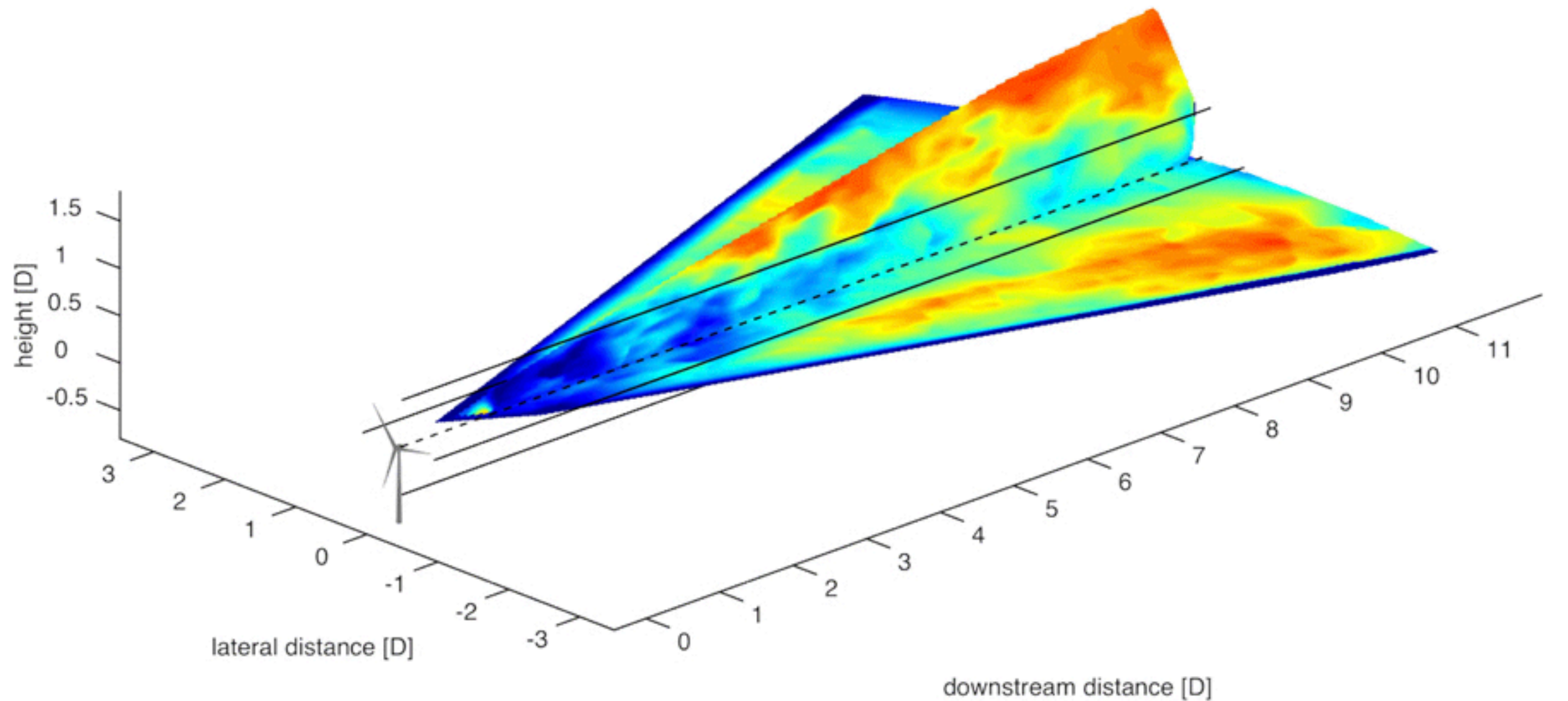
wind farm parametrisation does not include impact of the wind farm layout



Scanning the wind



From measurements to wind fields



WindLab

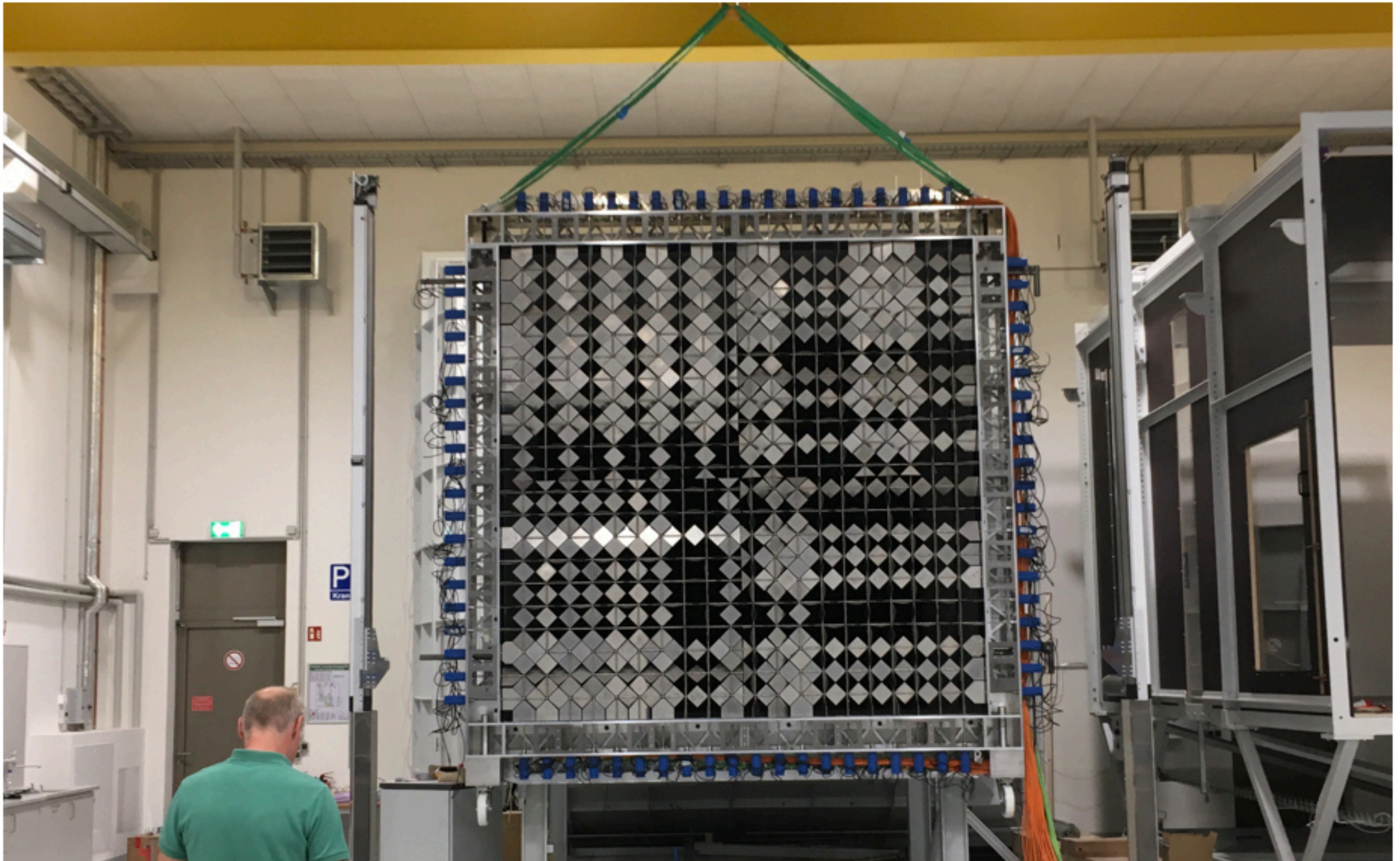
large turbulence wind tunnel ($v_{\max} > 40 \text{ ms}^{-1}$)



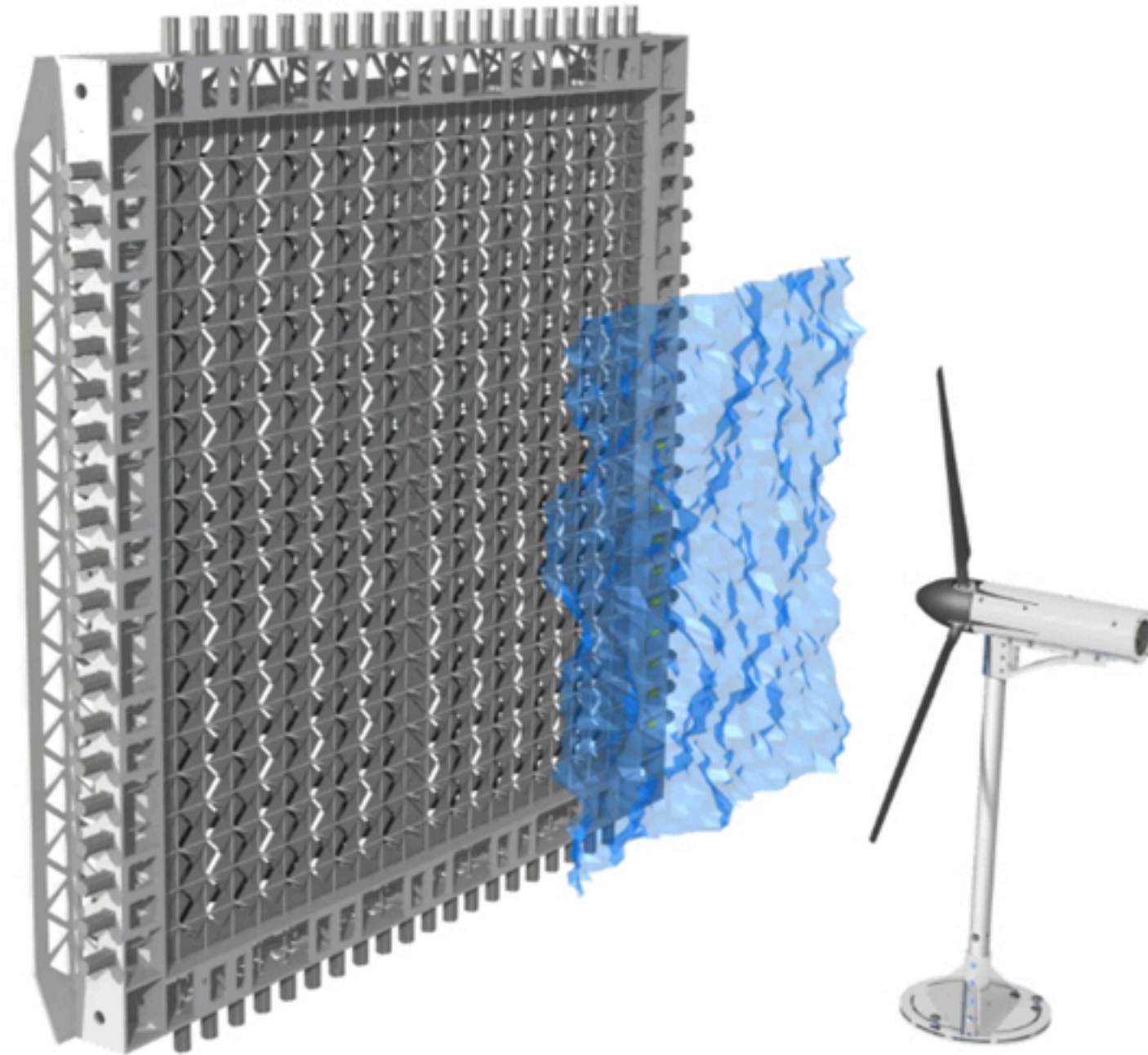
Sophisticated research wind turbine models



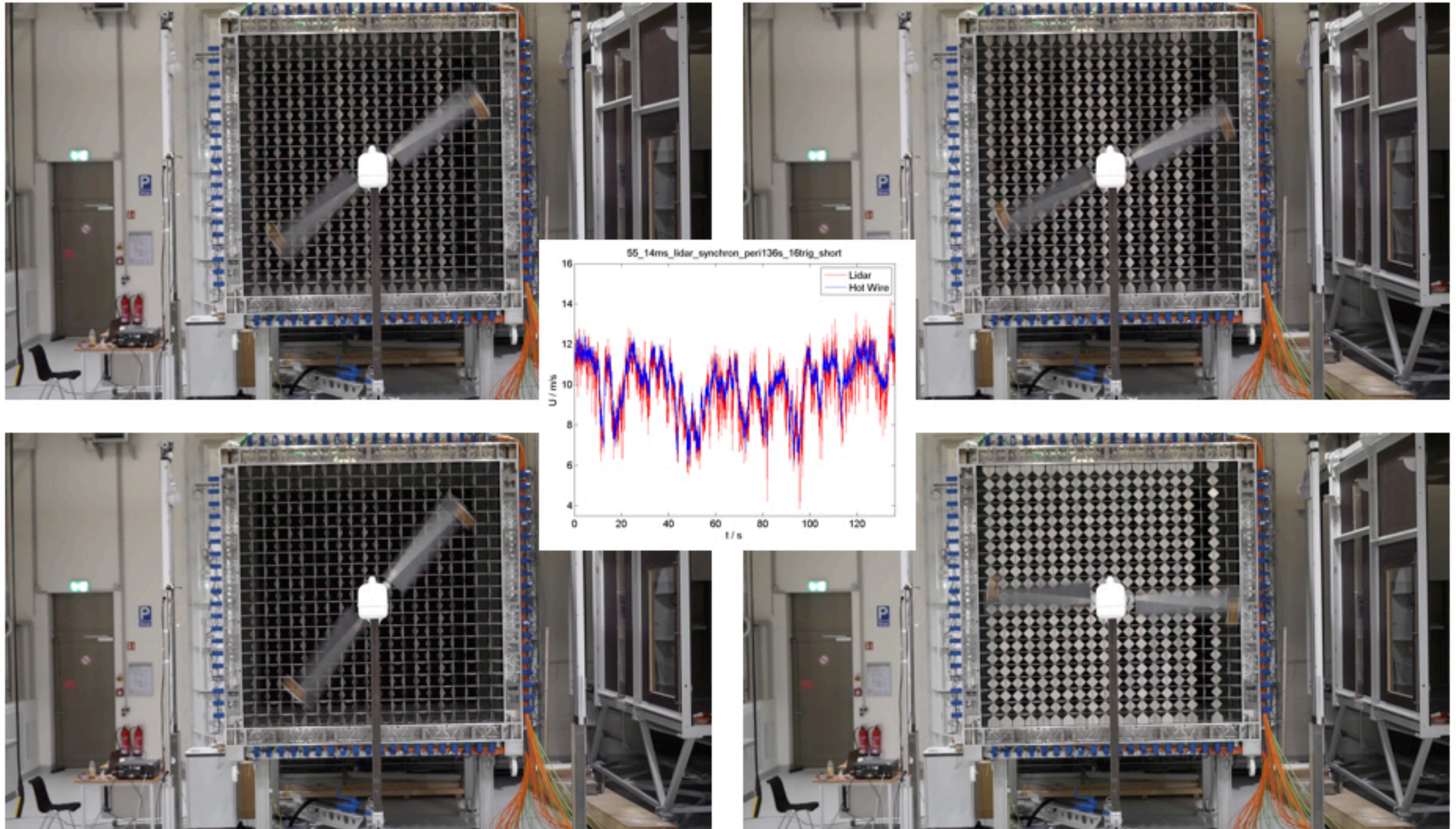
Reproducing controlled turbulences: active grid



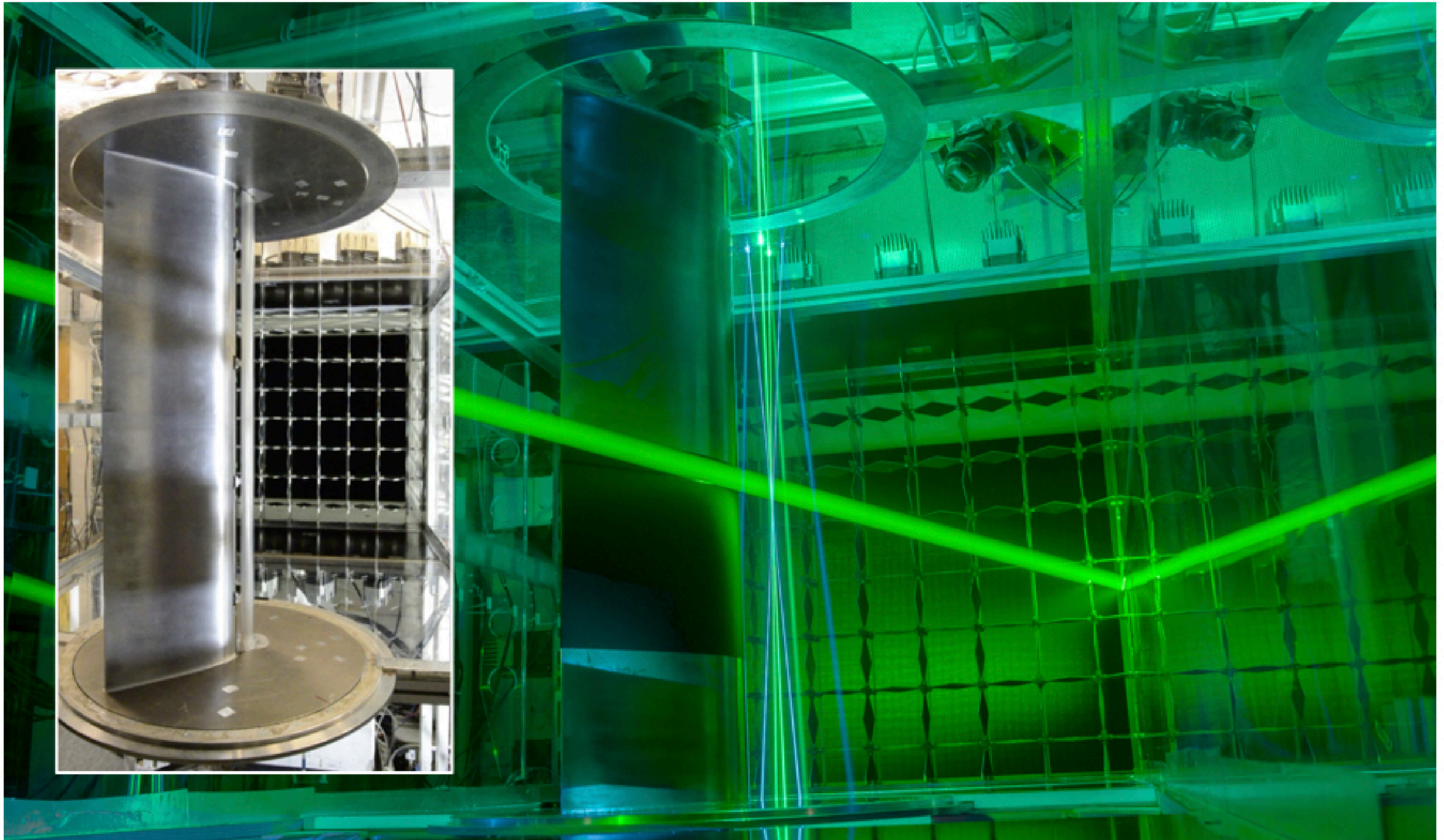
Reproducing controlled turbulences: active grid



Reproducing controlled turbulences: active grid



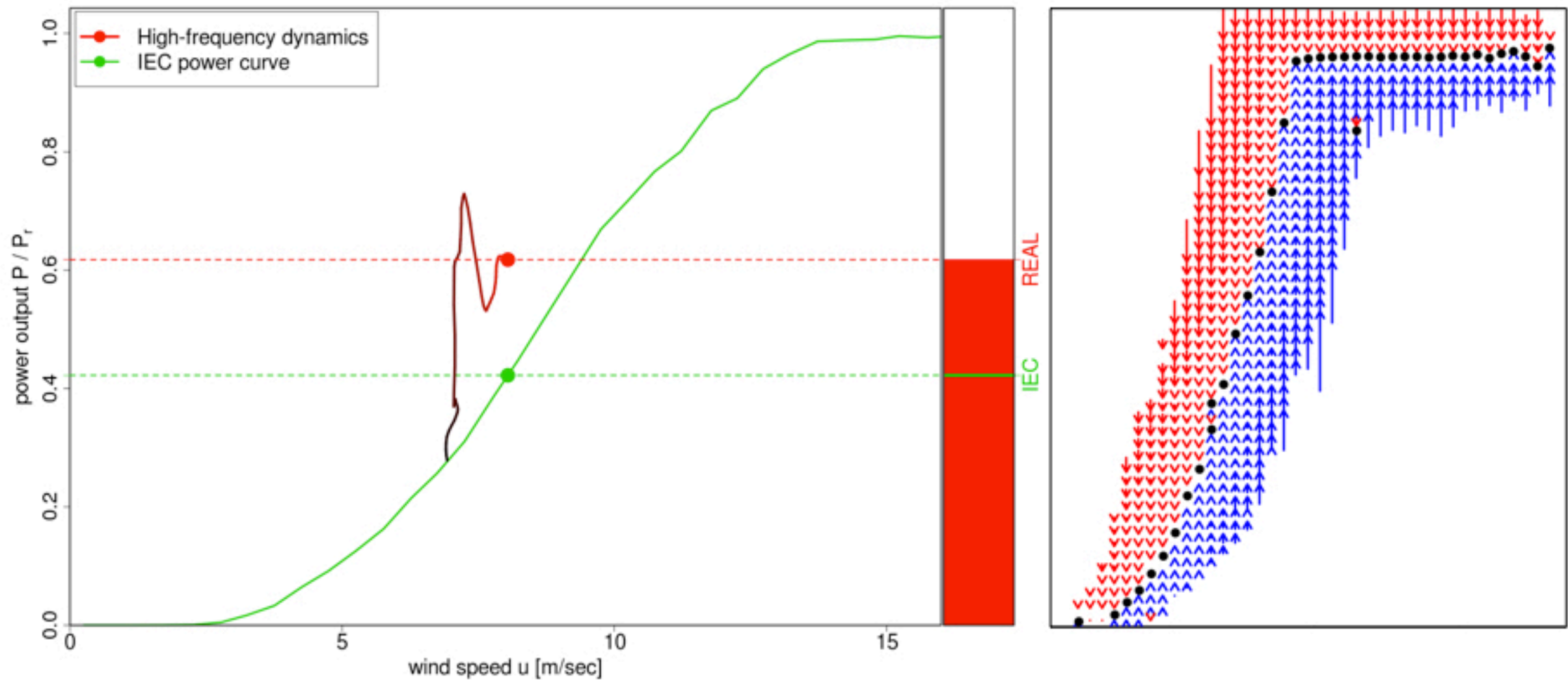
Next generation wind turbine design: e.g. smart blades



Next step – 1:1 scale research facility



Does a wind turbine filter all that turbulence? No!



謝謝

