Neue Entwicklungen in der Windenergieforschung

– warum Windenergie ein spannendes Feld für die Physik ist

Dr. Stephan Barth

ForWind - Zentrum für Windenergieforschung

Forschungsverbund Windenergie

- 11 Standorte in 6 Bundesländern
- ca. 600 MitarbeiterInnen
  - DLR (6 Institute)
  - ForWind (29 Institute)
  - Fraunhofer IWES
- Kooperationsrahmenvertrag

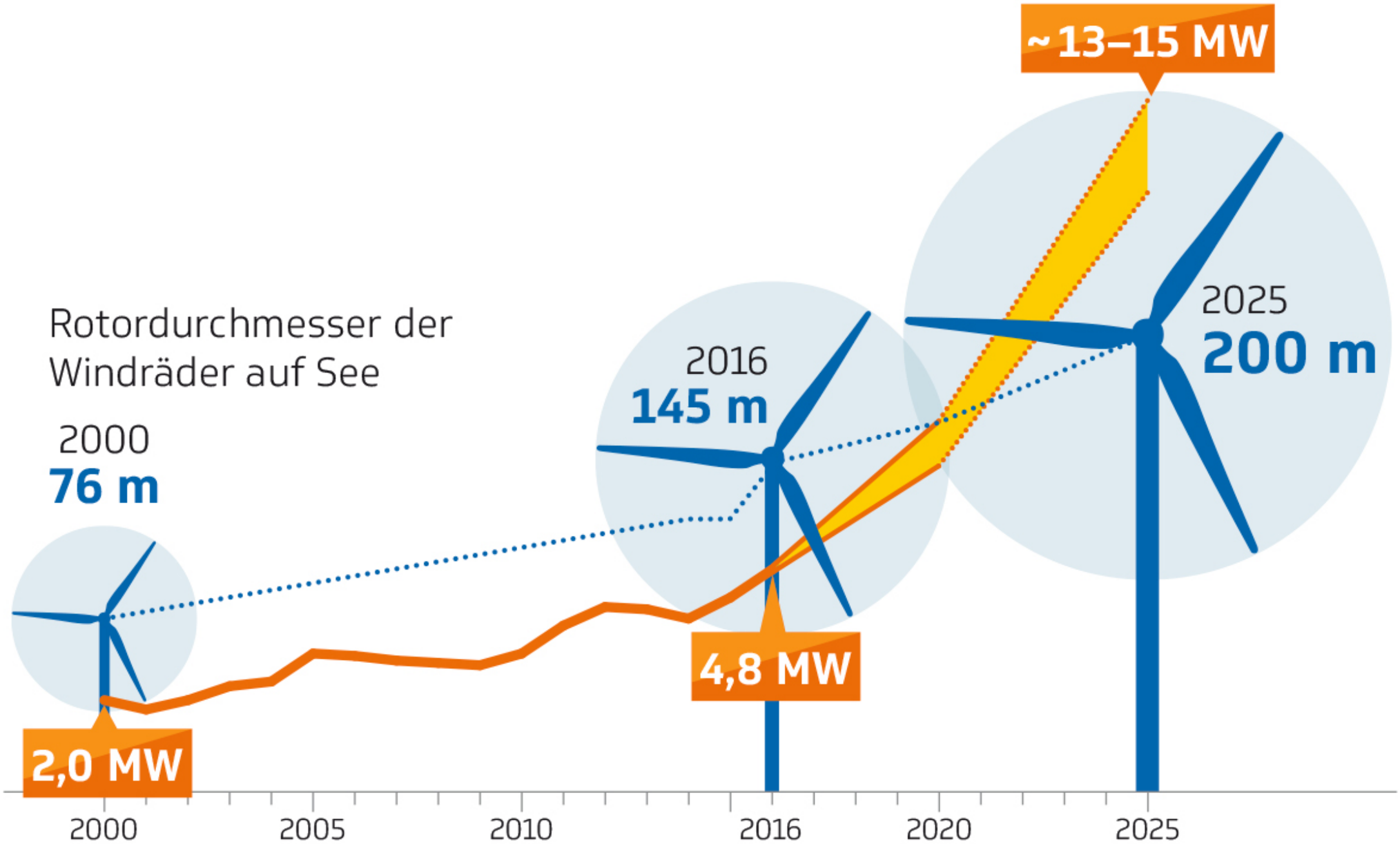
Forschungsverbund Windenergie

Deutsches Zentrum für Luft- und Raumfahrt

ForWind Zentrum für Windenergieforschung

Fraunhofer IWES

DIE LEISTUNG WÄCHST



Durchschnittlich installierte Leistung neuer Windenergieanlagen in Europa (in Megawatt); Voraussagen der Hersteller und Betreiber bis 2025

Darstellung: Ahnen&Enkel

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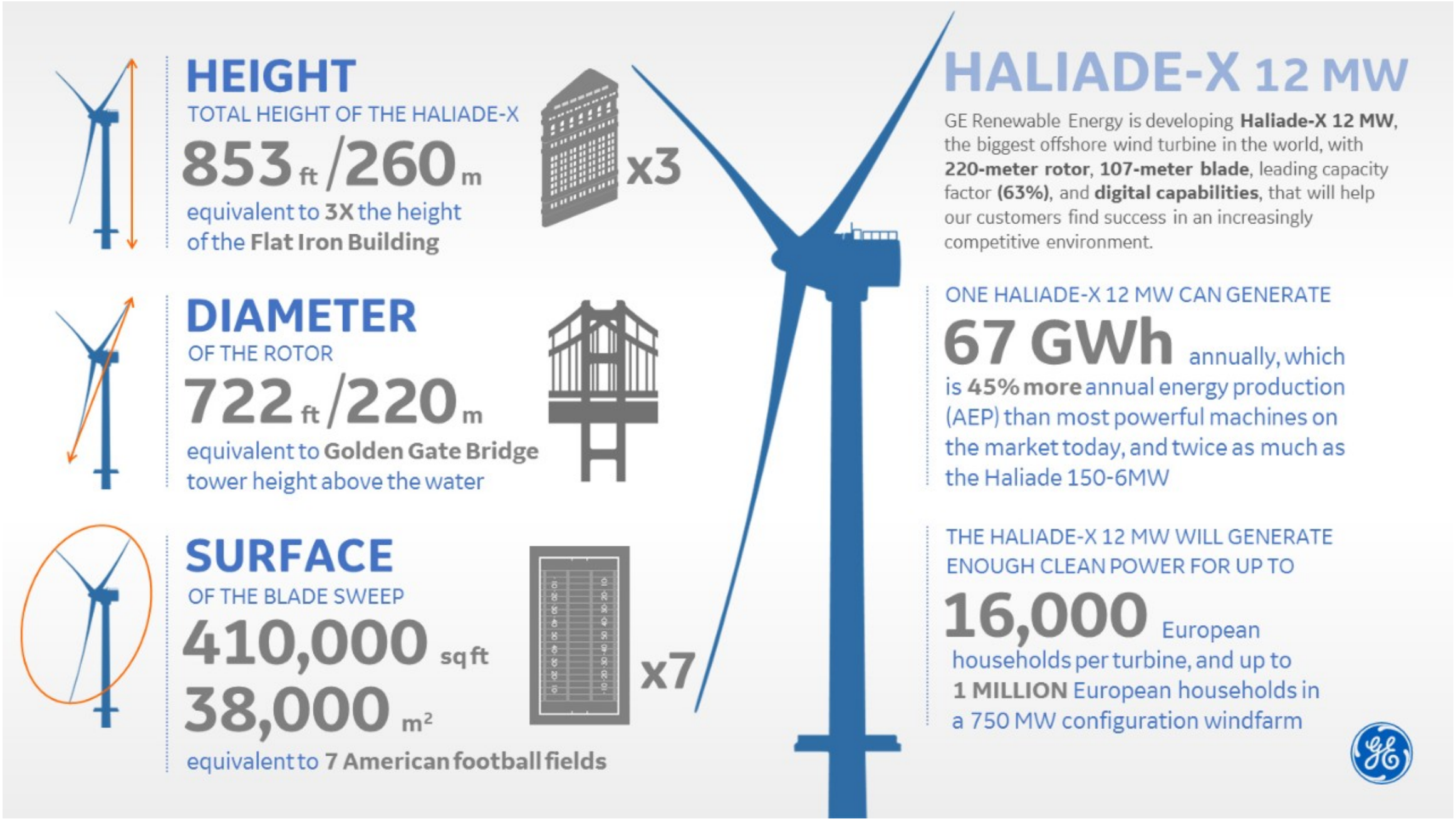
Meldung vom 01.03.2018



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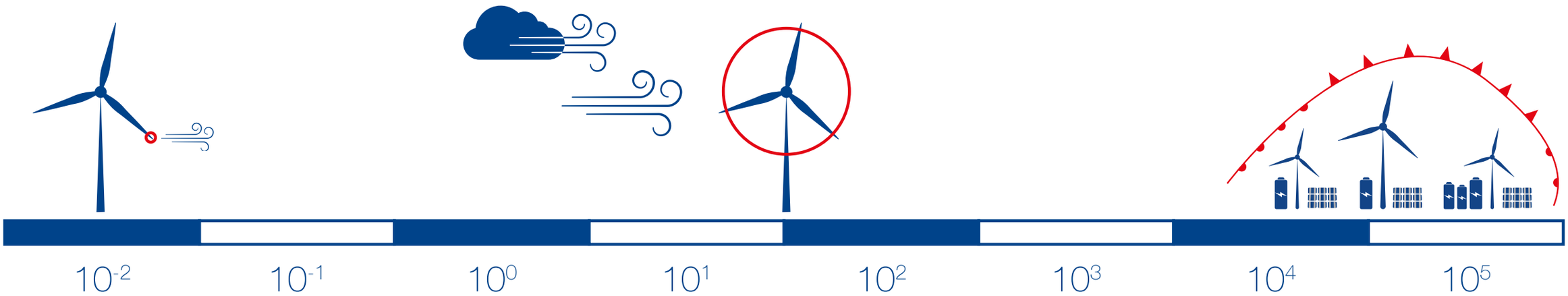
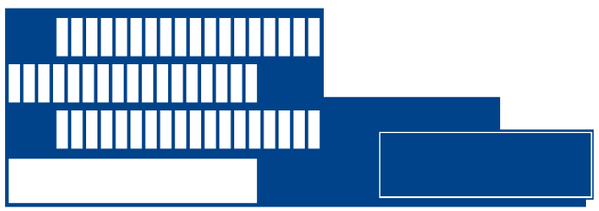
Herausforderung
geschlossene Modellierungskette über viele Skalen



Simulation

Großrechner

Experiment



Testzentren

in situ

Freifeld

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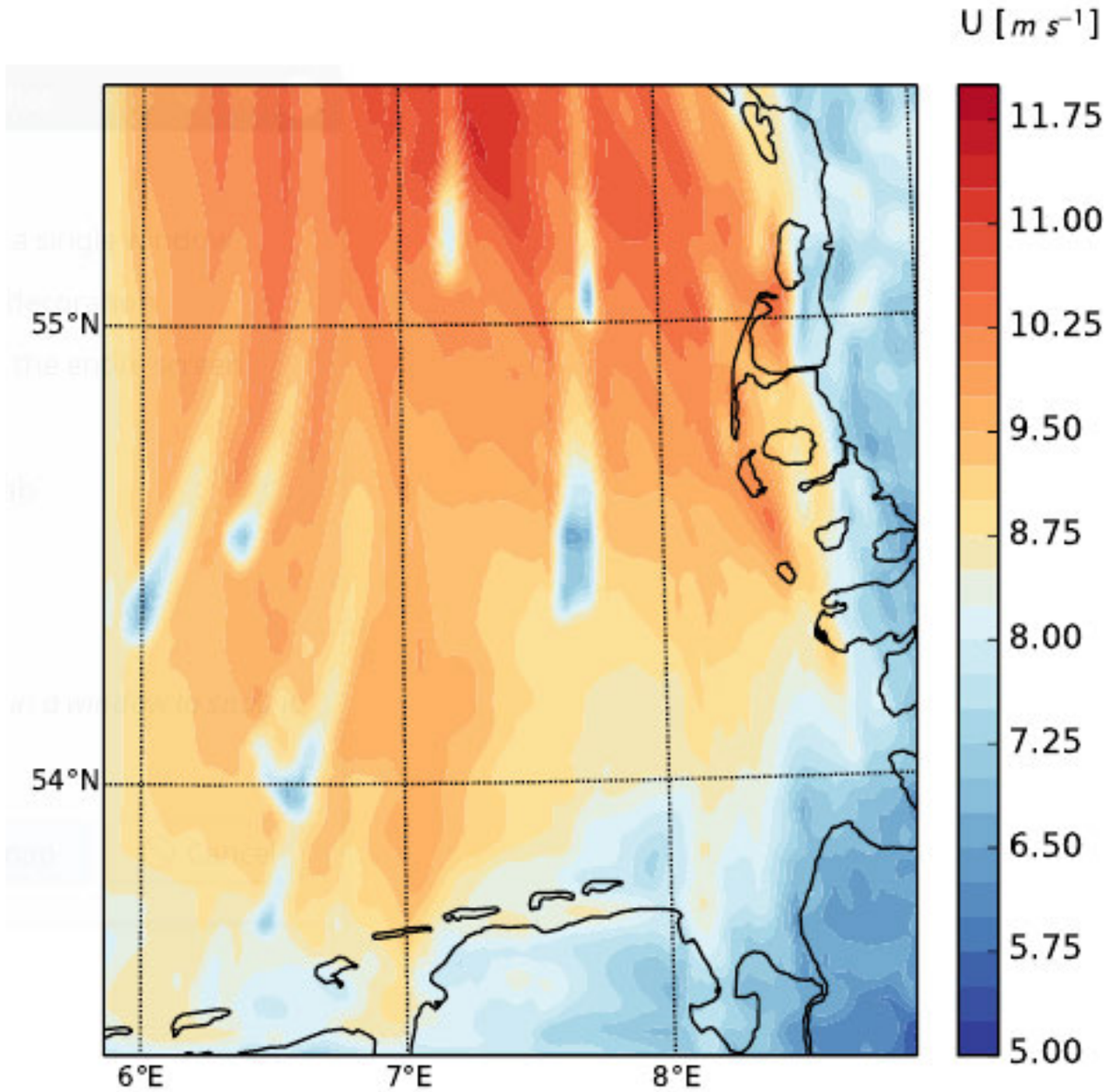
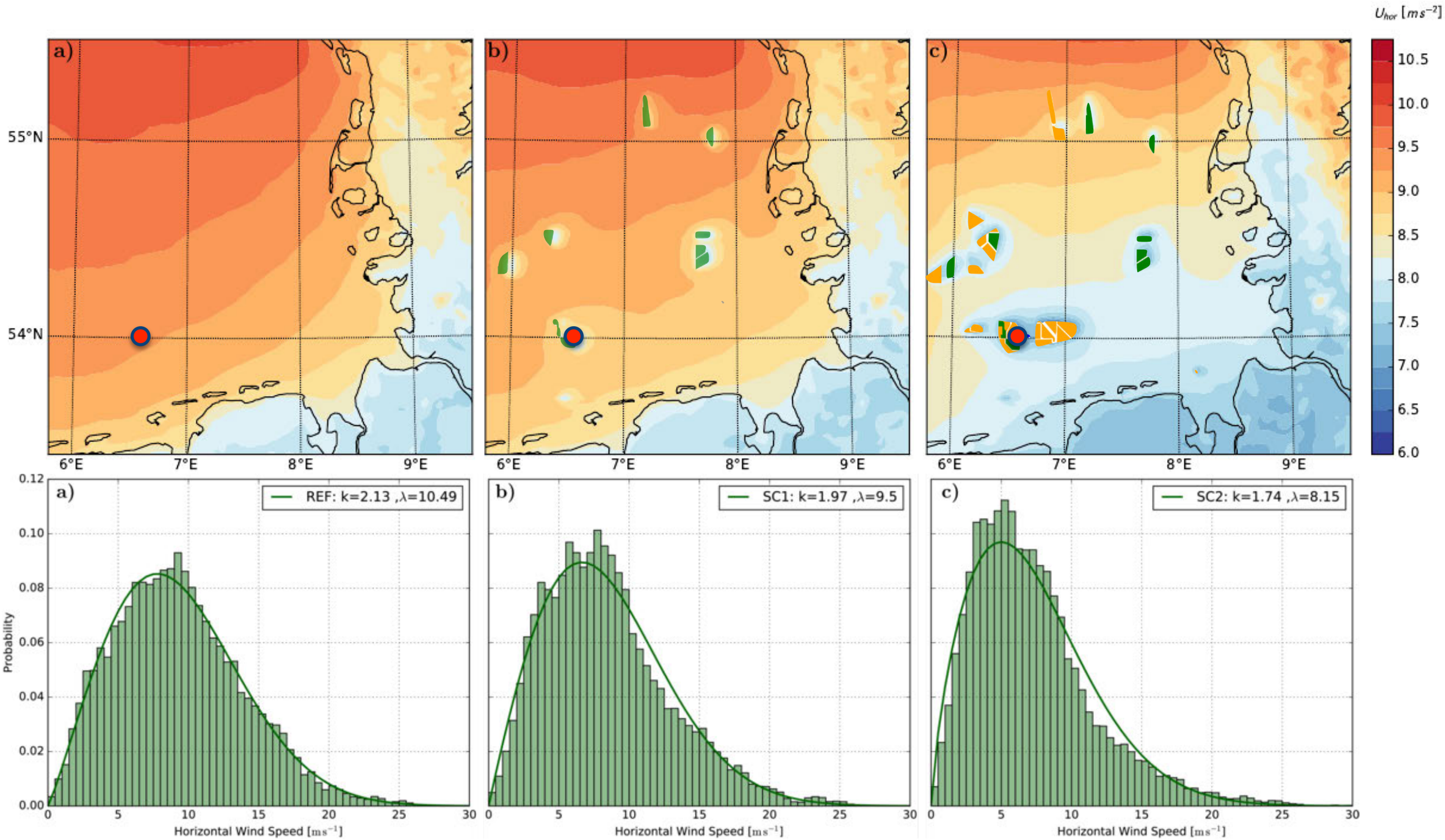
Fluctuating wind fields

- 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



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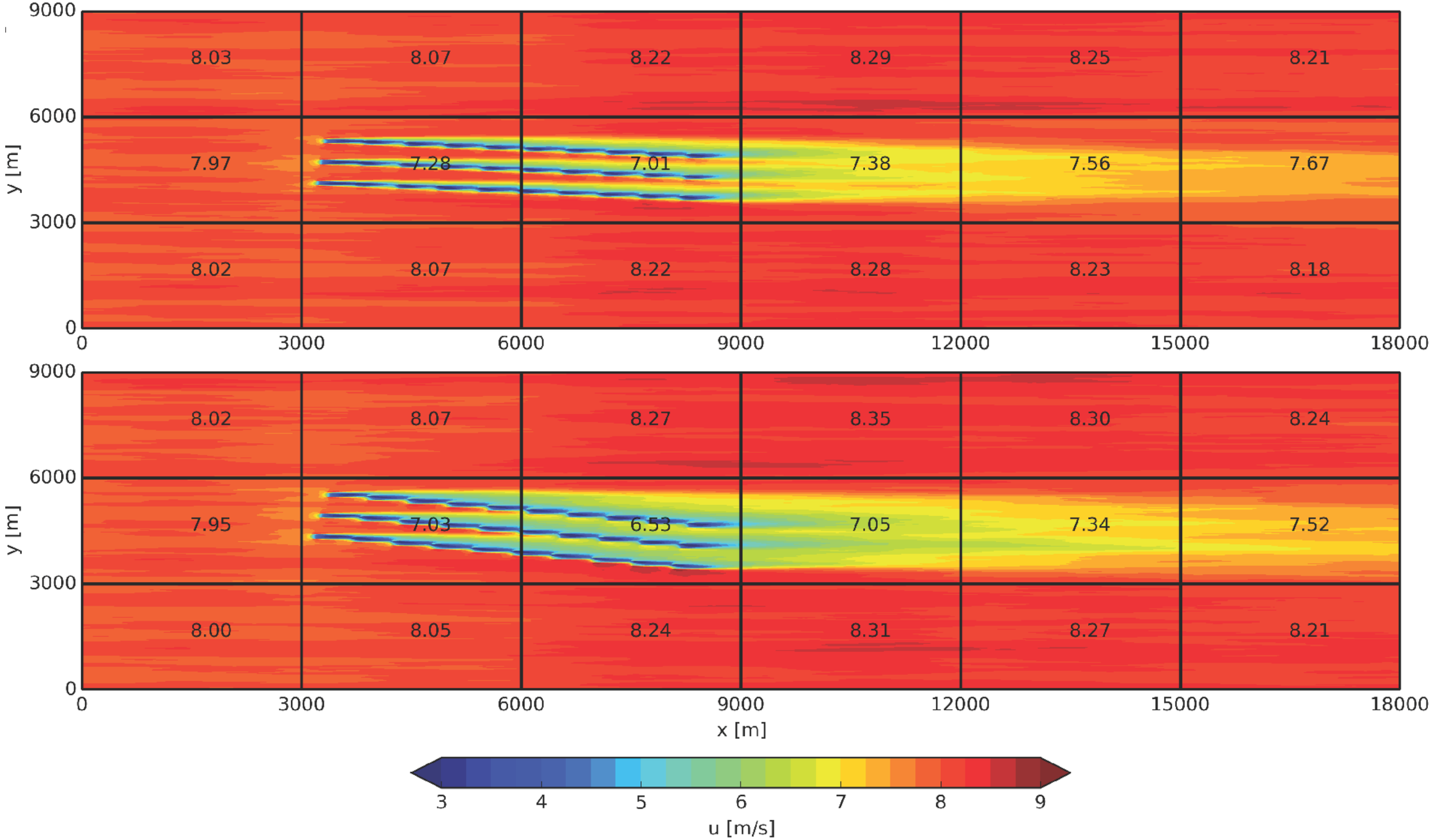
Limitations

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



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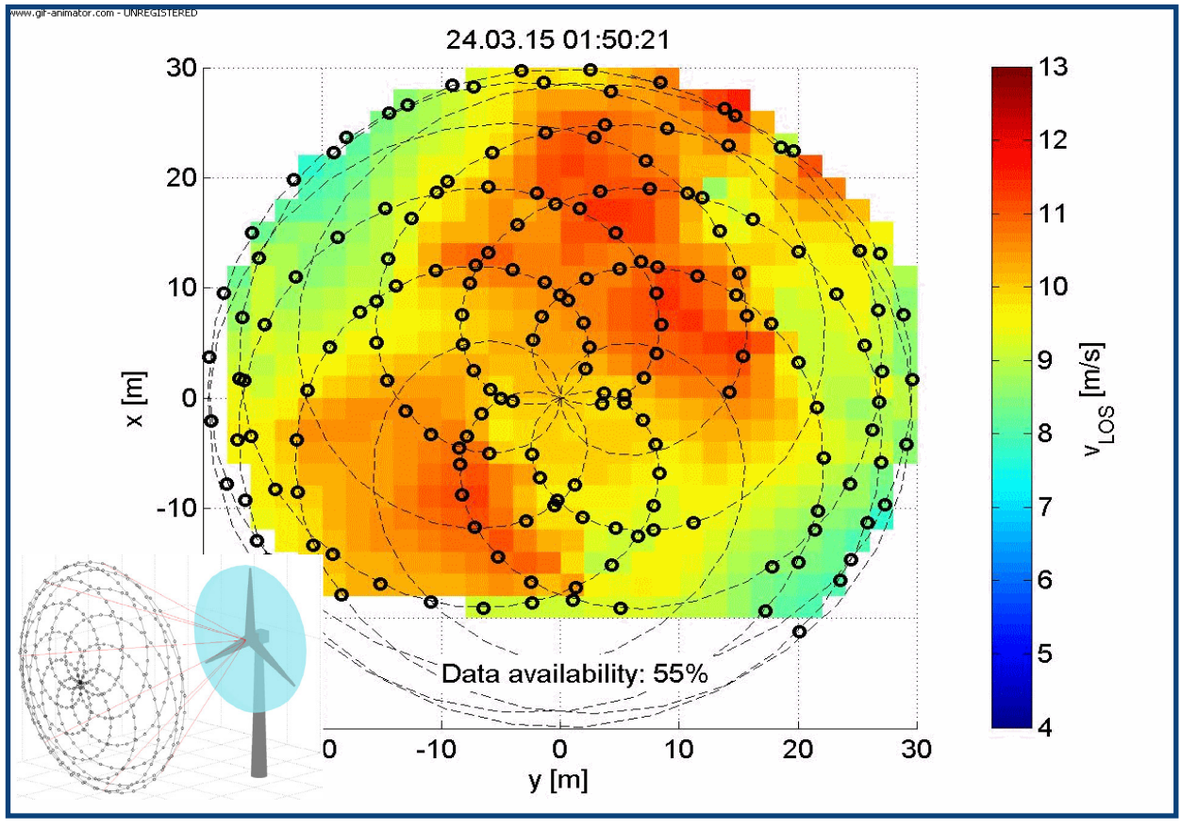
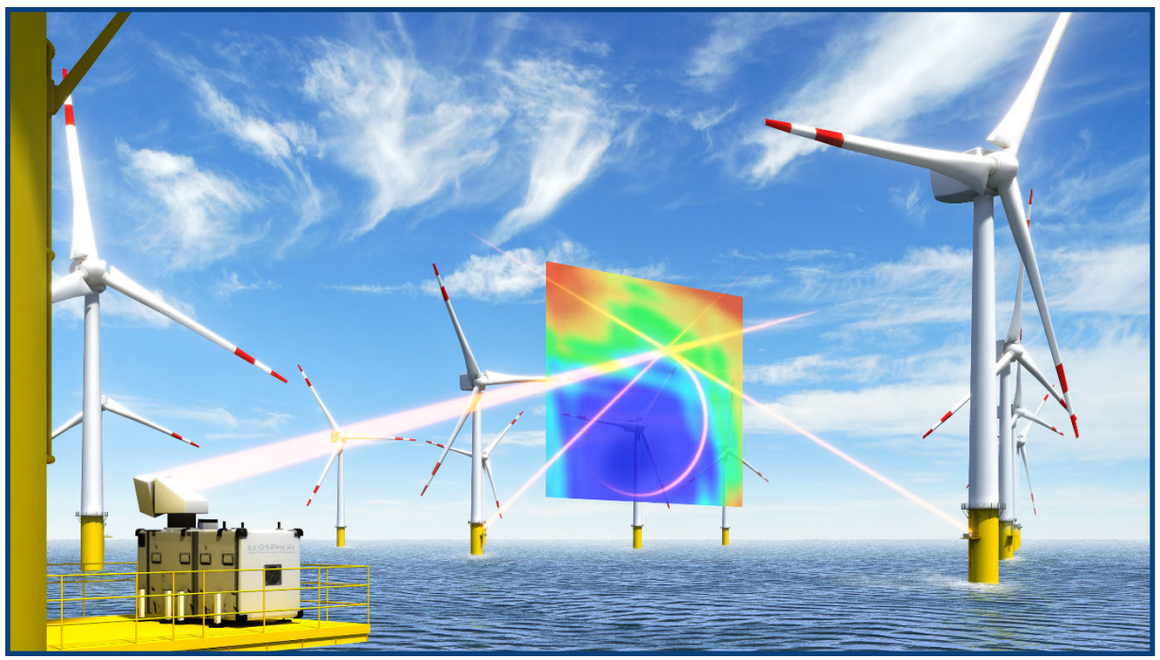
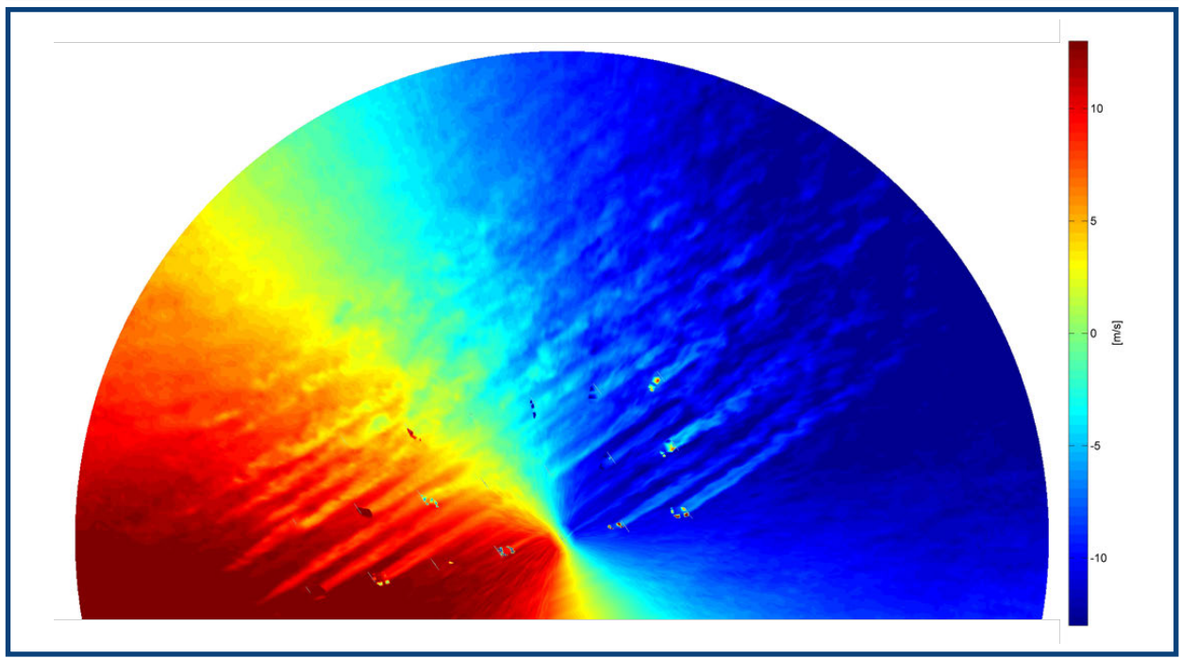
Wakes als große Herausforderung im Betrieb

Short- und Long-range WindScanner







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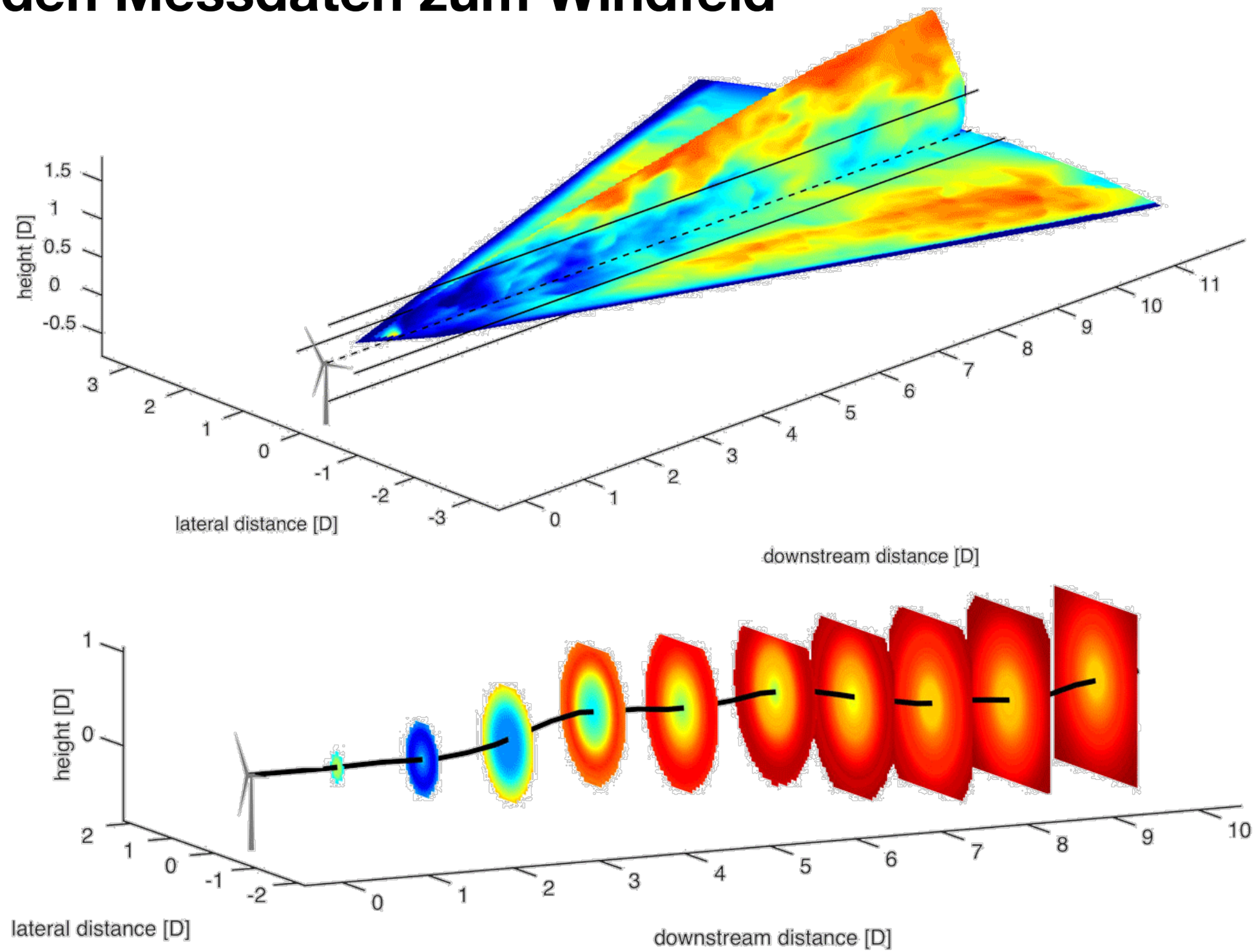
Von den Messdaten zum Windfeld



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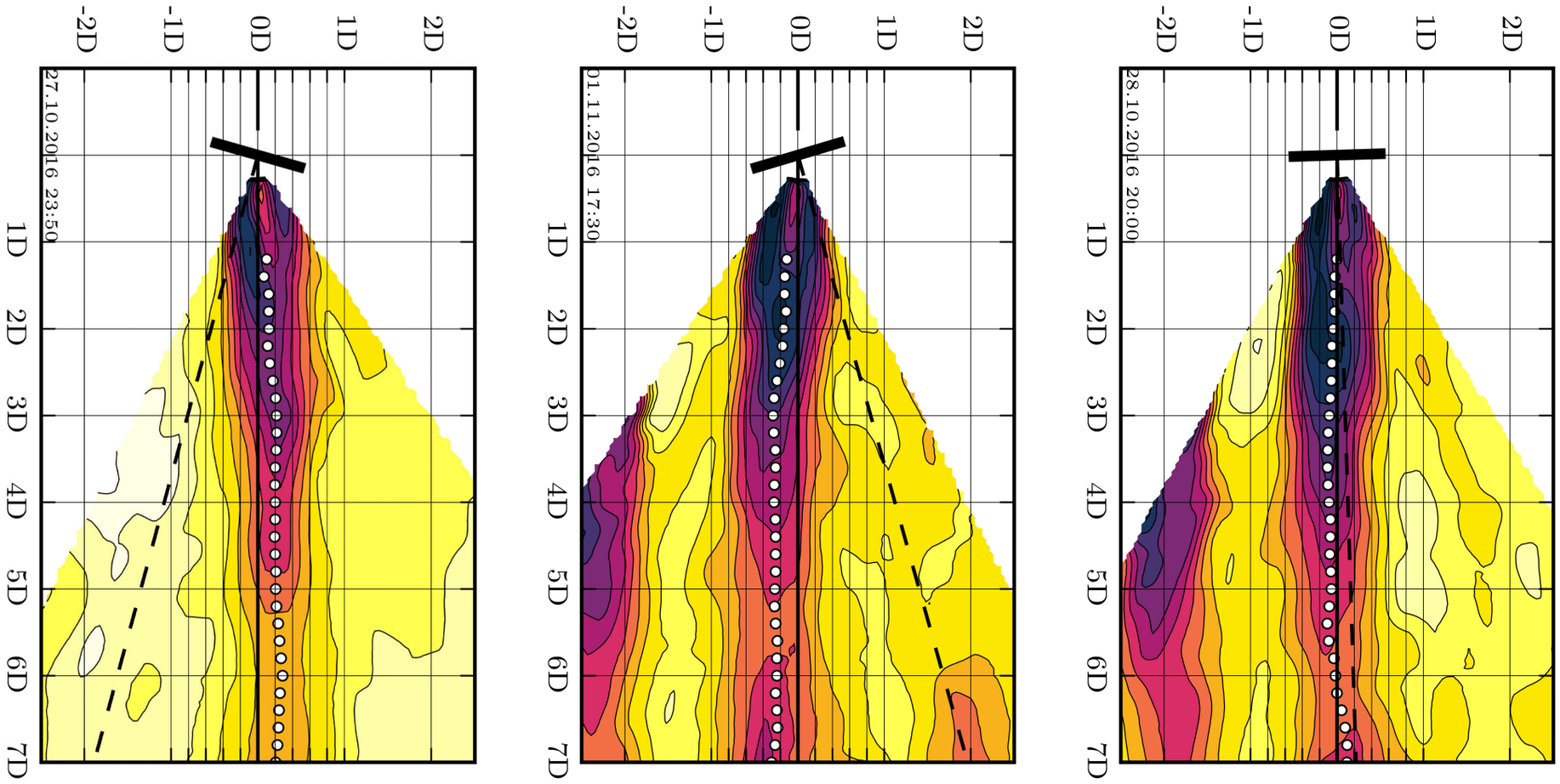
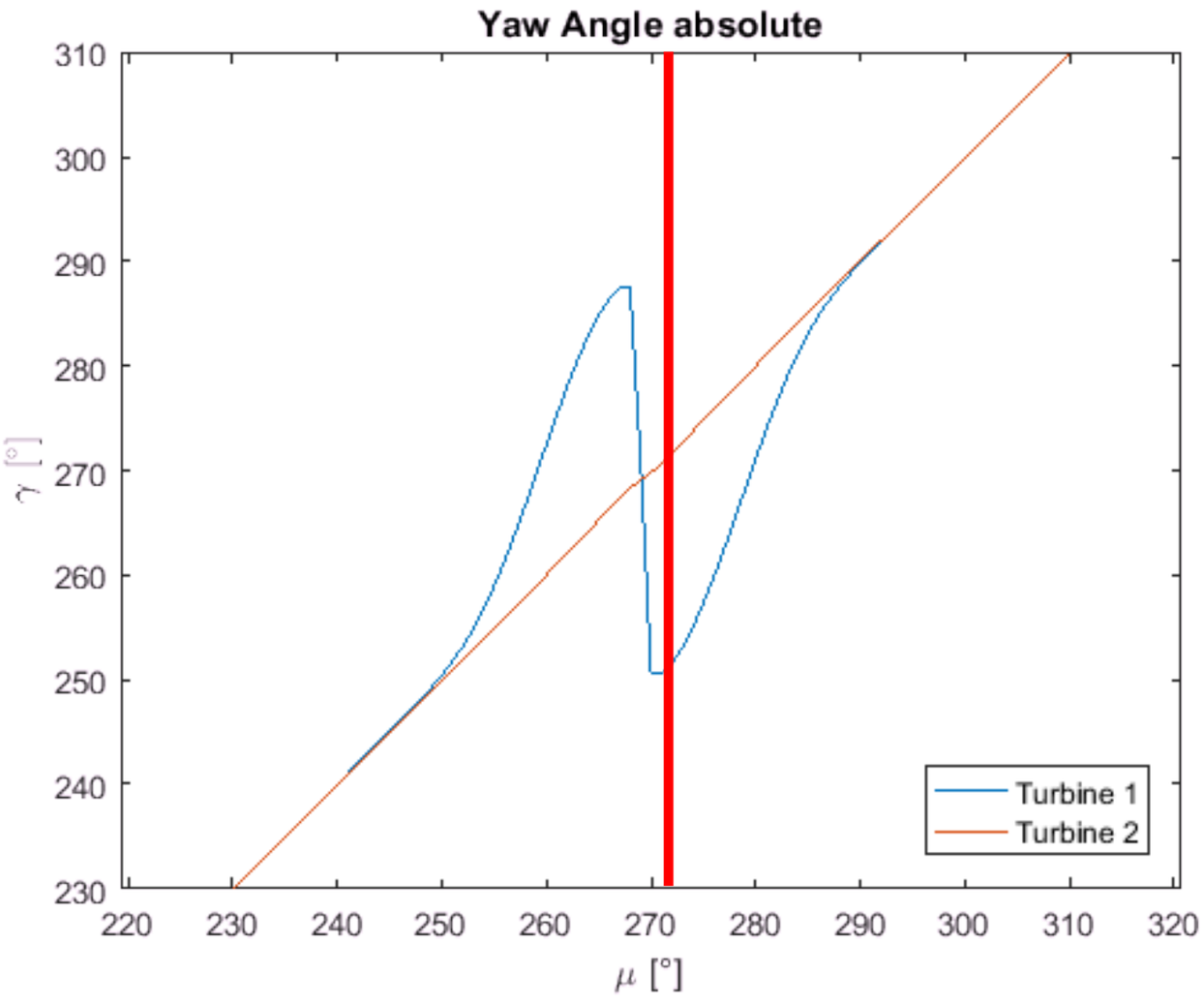
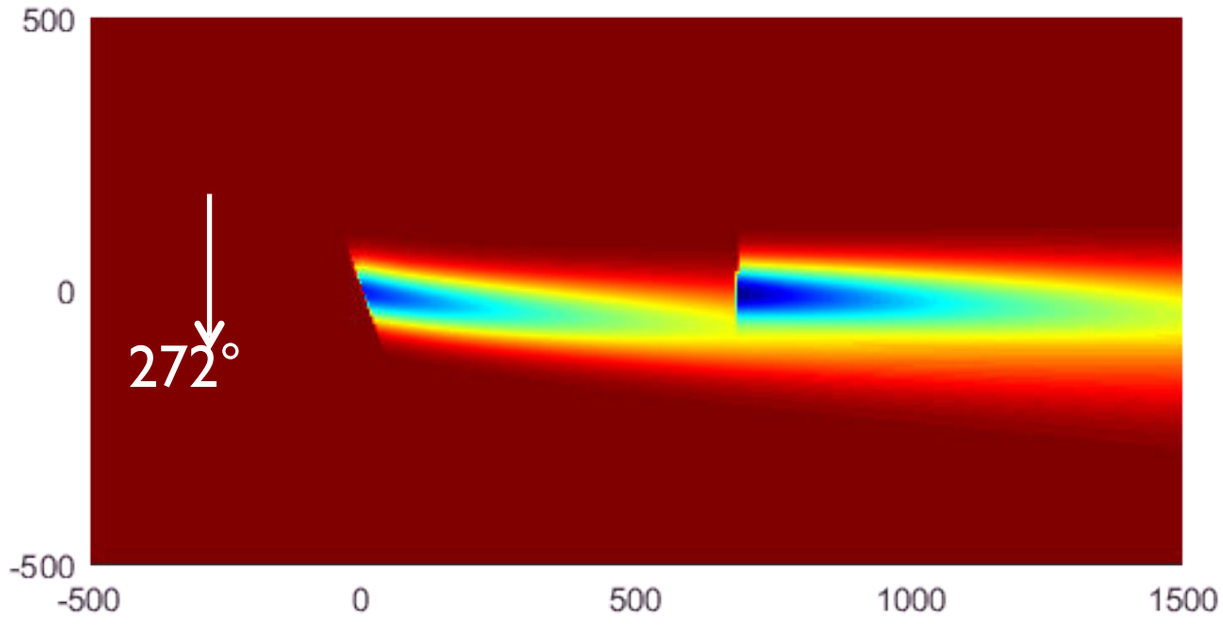
Aktive Beeinflussung des Nachlaufs



Active wake deflection in application





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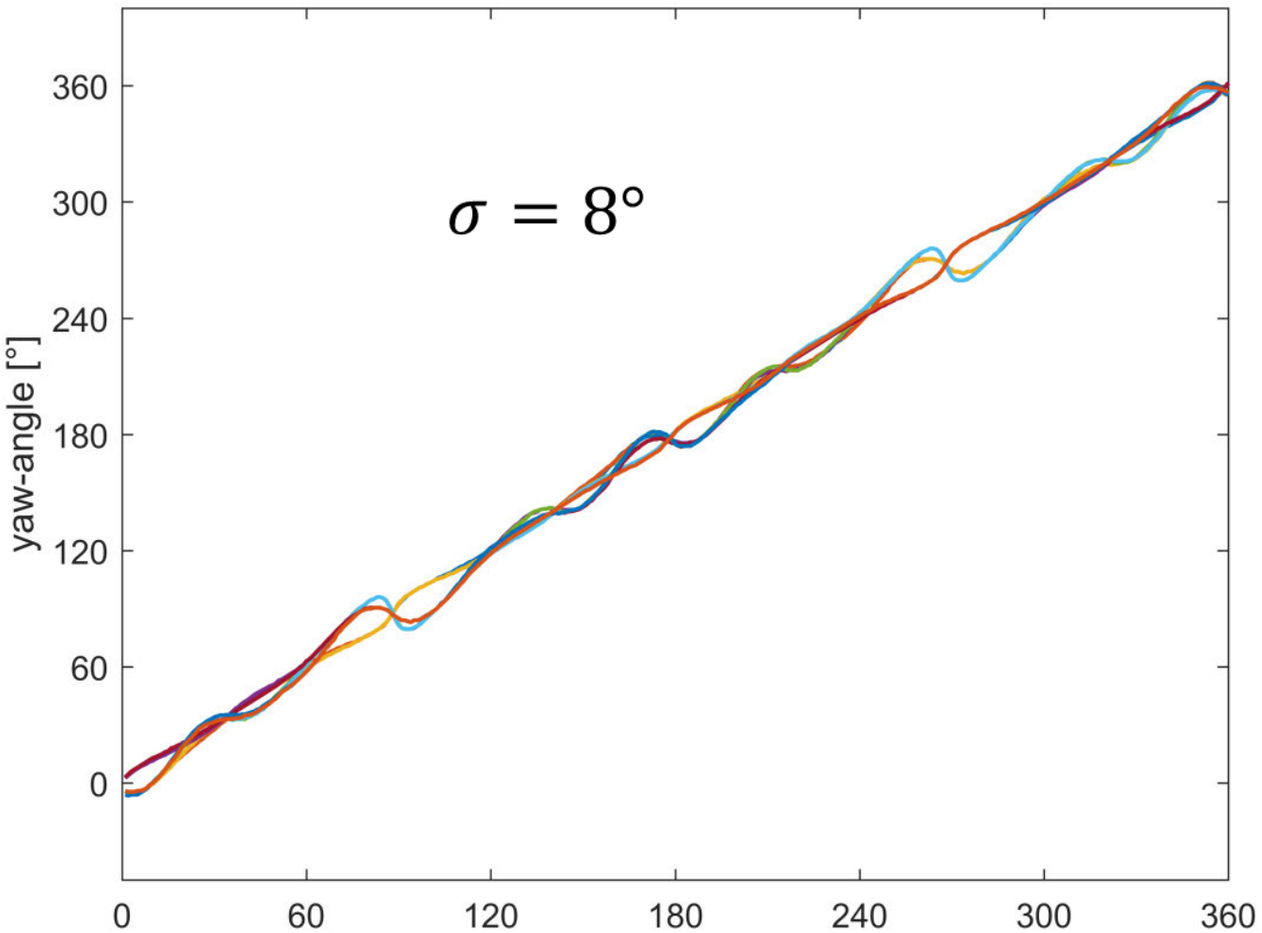
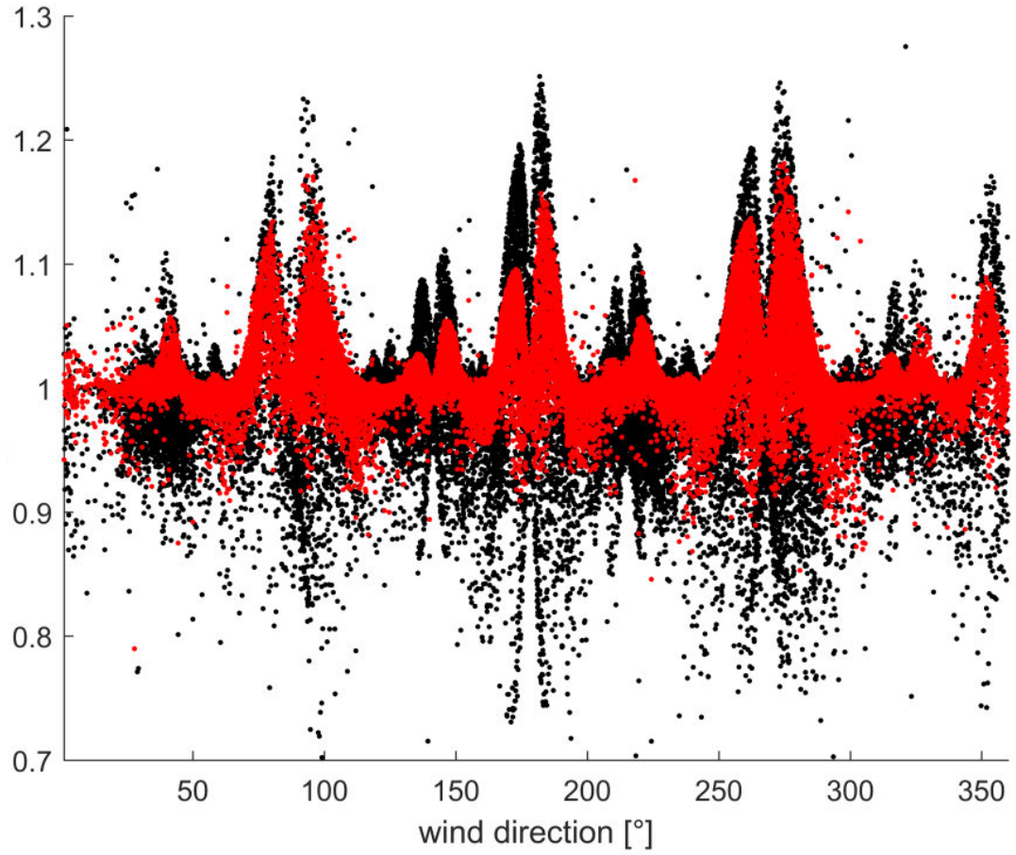
Results for Robust Wake Steering





$$\emptyset\left(\frac{P_{\mathrm{opt}}}{P_{\mathrm{con}}} - 1\right) = 1.03\ \%$$

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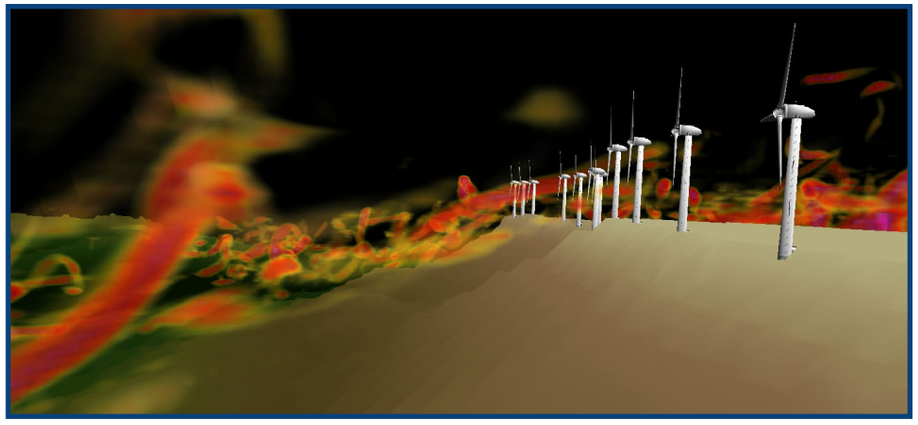
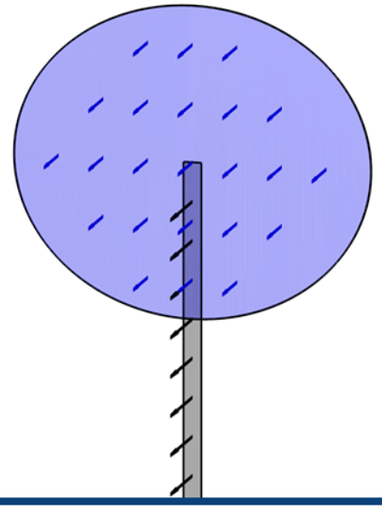
Strömungssimulation auf unterschiedlichen Skalen

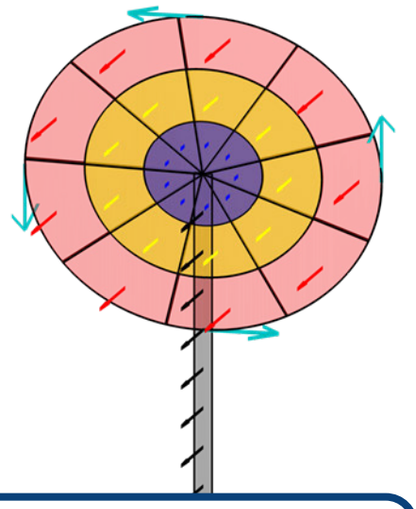
palm OpenFOAM Nektar WRF

- Betrieb und Entwicklung des PArallelisierten Large-Eddy SimulationsModells PALM
- Betrieb und Priorisierung eigener Hochleistungsrechner
- Expertise in der CFD-Modellbildung und Anpassung an HPC-Architekturen

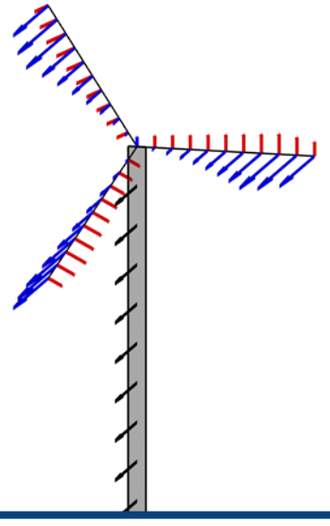




Actuator disk model (**ADM**)



improved ADM (**ADM-R**)



Actuator line model (**ALM**)

Wind turbine: FAST

Atmospheric flow: PALM

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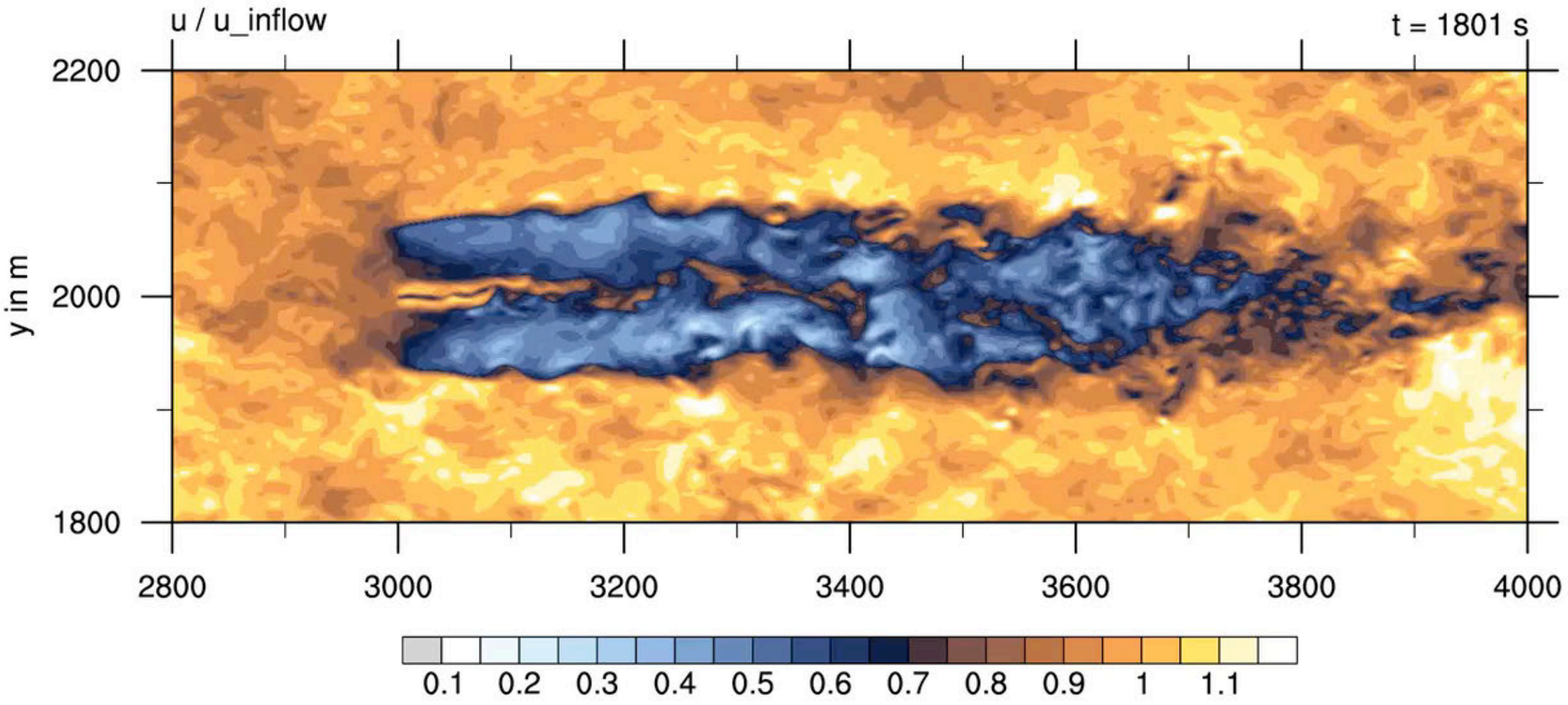
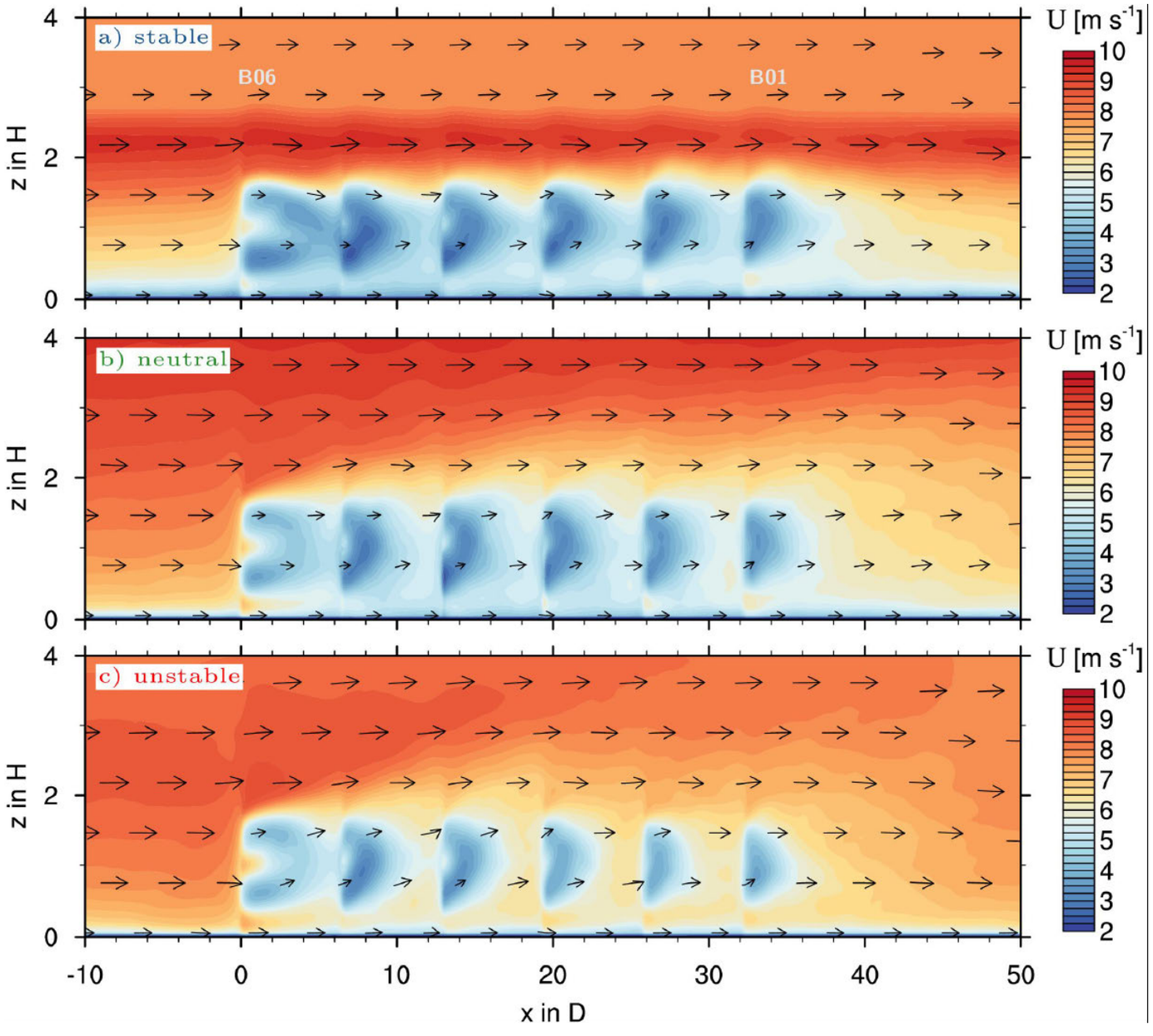
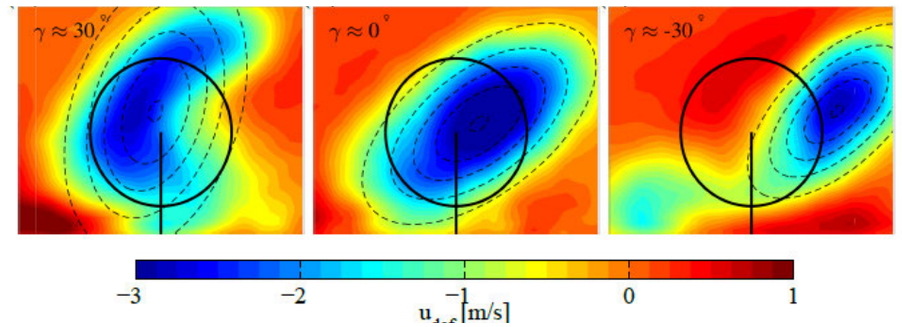
Enhanced Actuator Disk Model (with BEM)



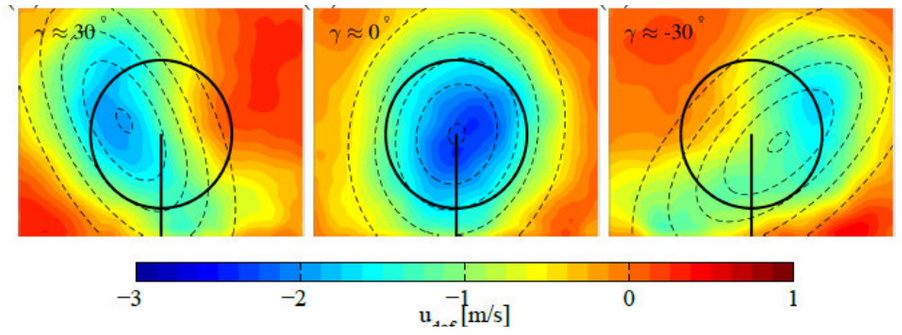
Kopplung von Meteorologie und CFD



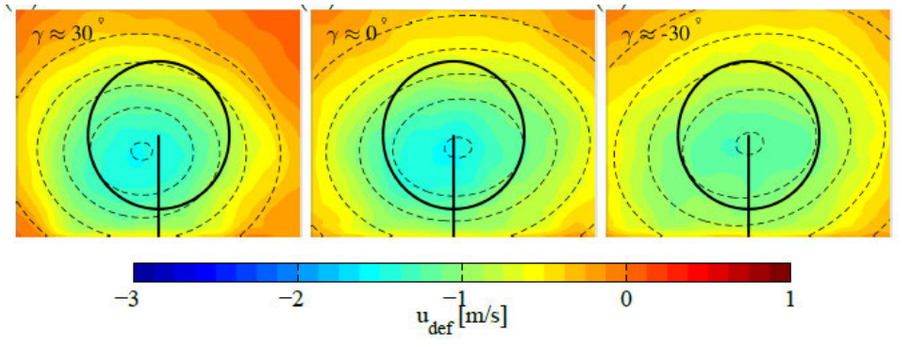
stabil



neutral



instabil



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WindLab
Großer Turbulenz-Windkanal

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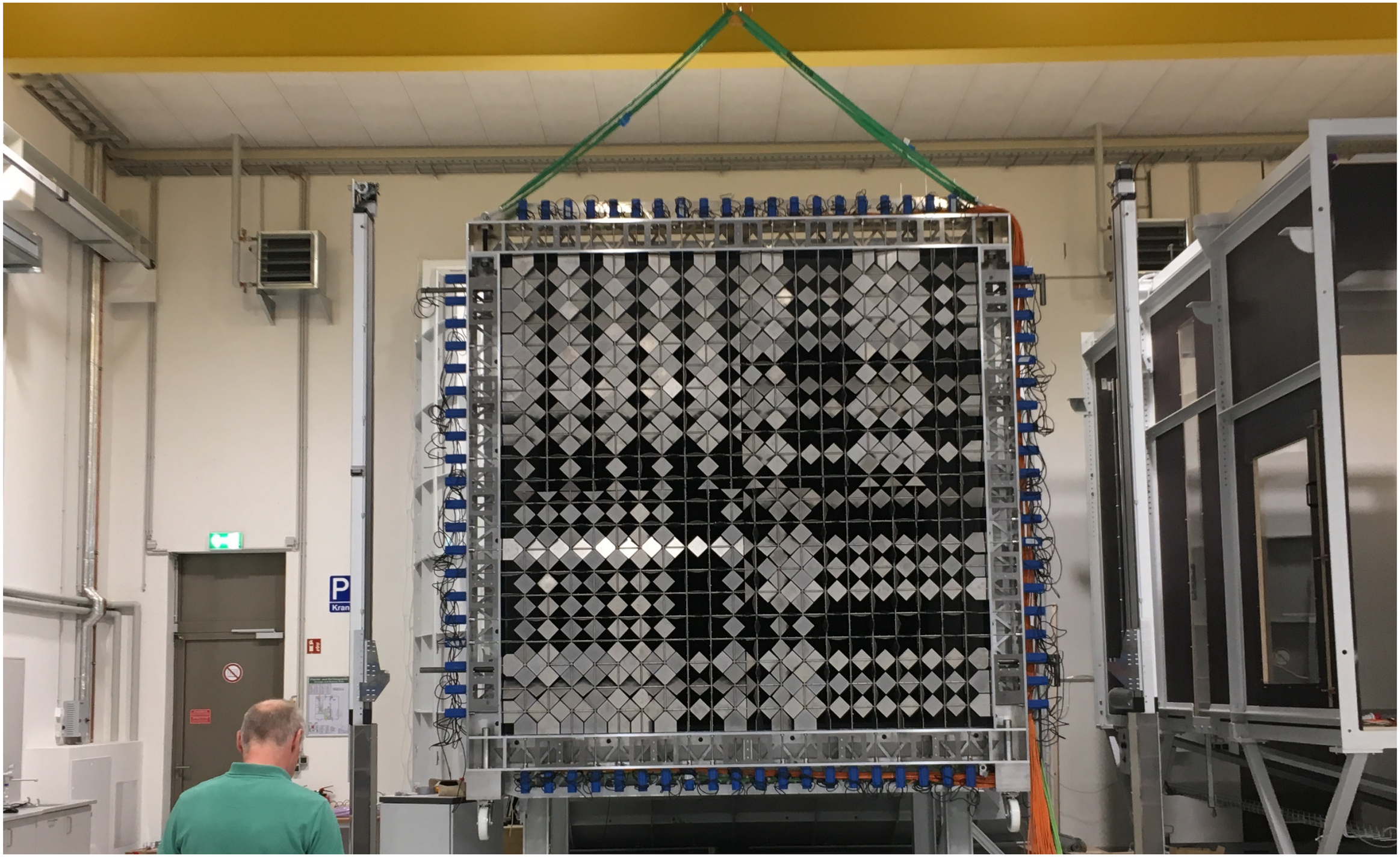
Aktives Gitter zur Turbulenzerzeugung



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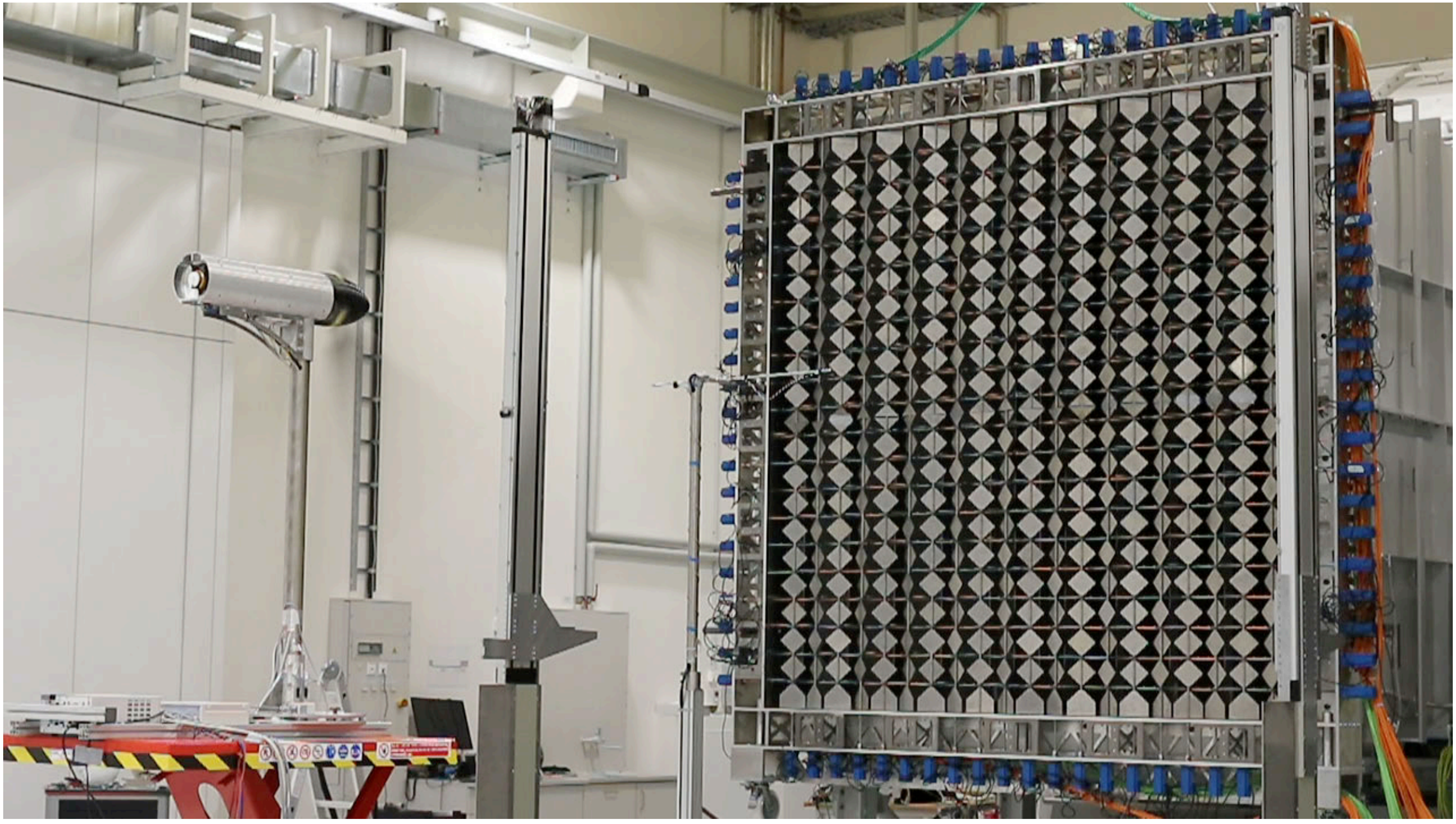
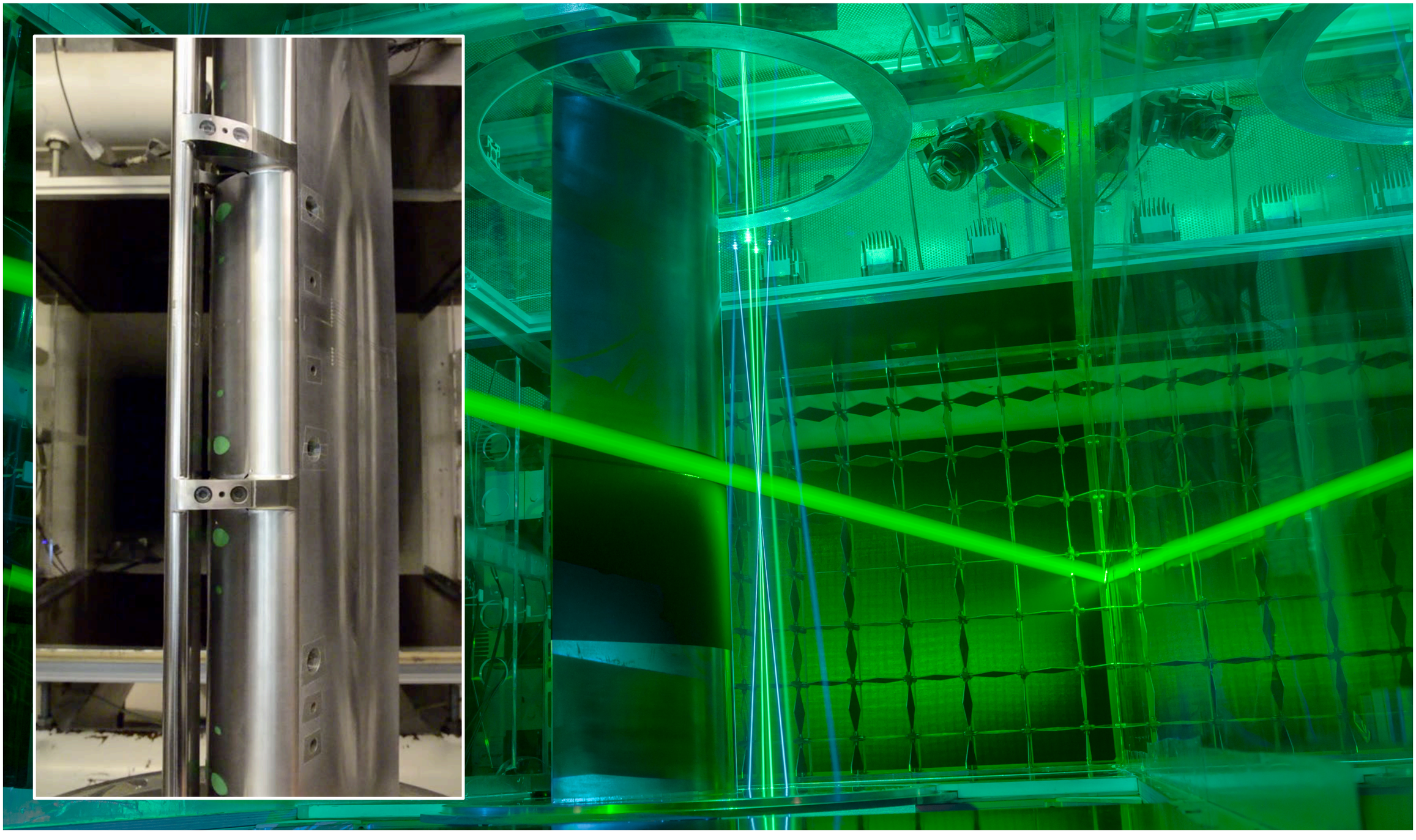
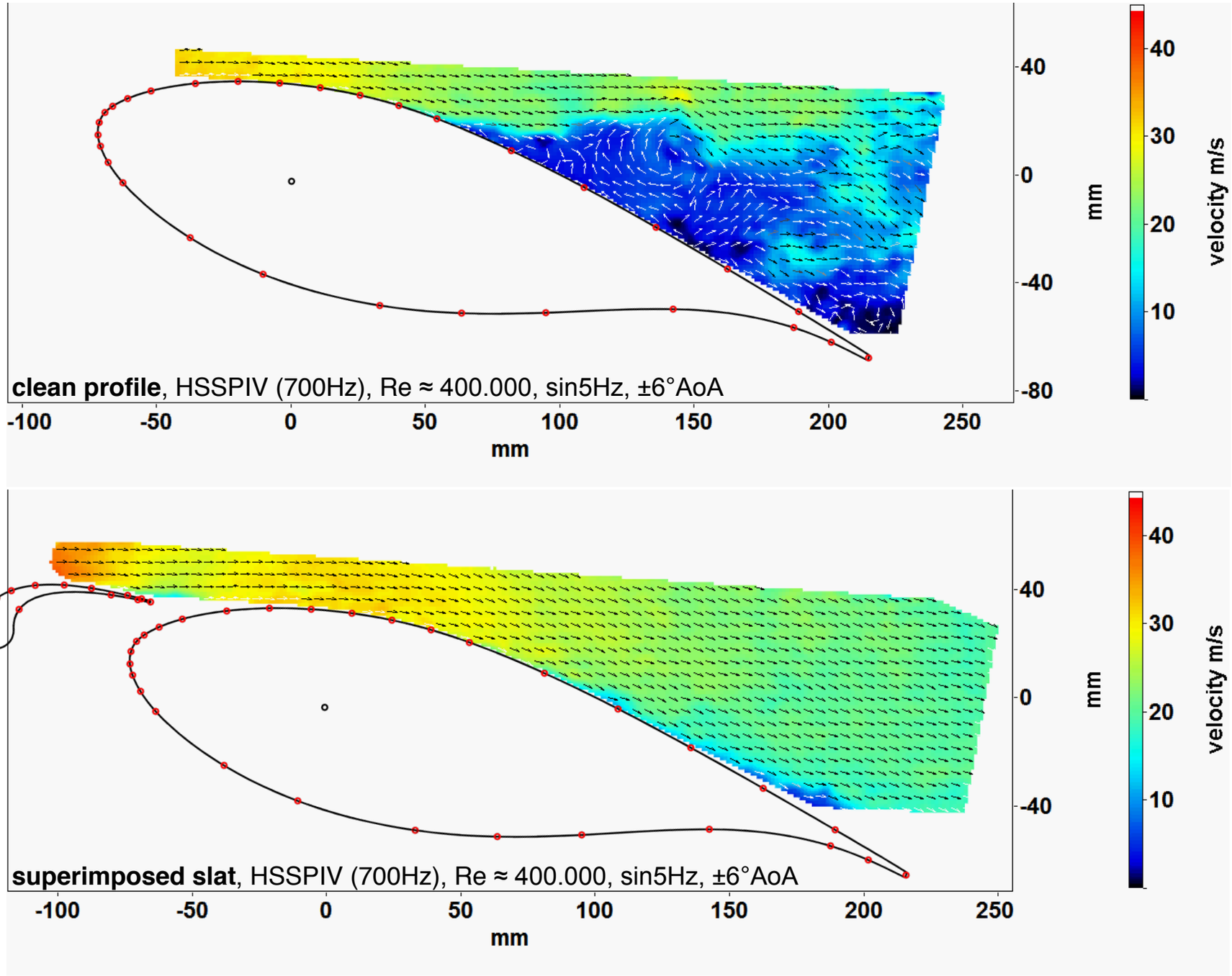
Aktives Gitter zur Turbulenzerzeugung



Potentiale und Machbarkeit von Smart Blades



High-Speed Stereo Particle Image Velocimetry



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Validierung? Experimente!

DFWind - Deutsche Forschungsplattform Windenergie

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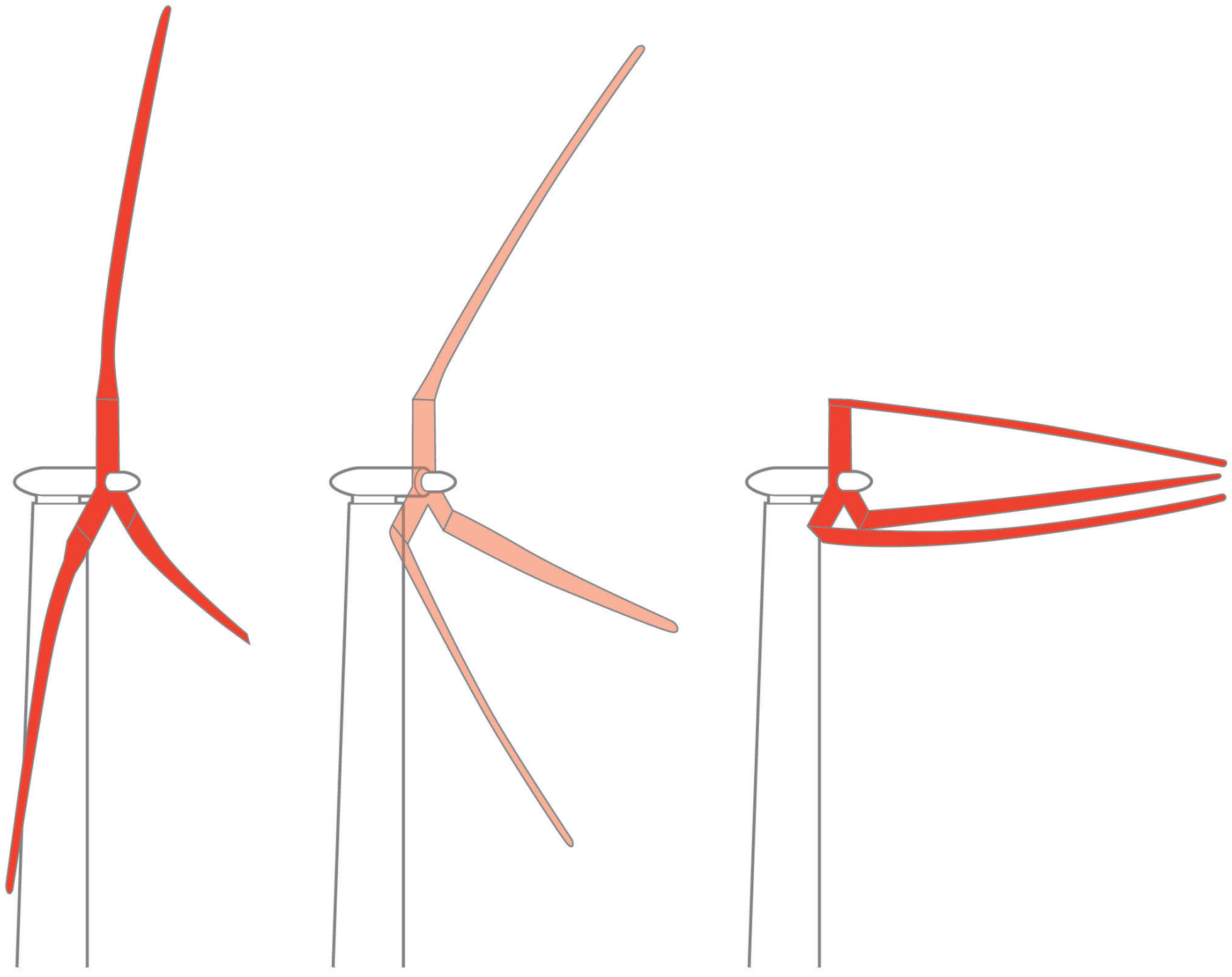
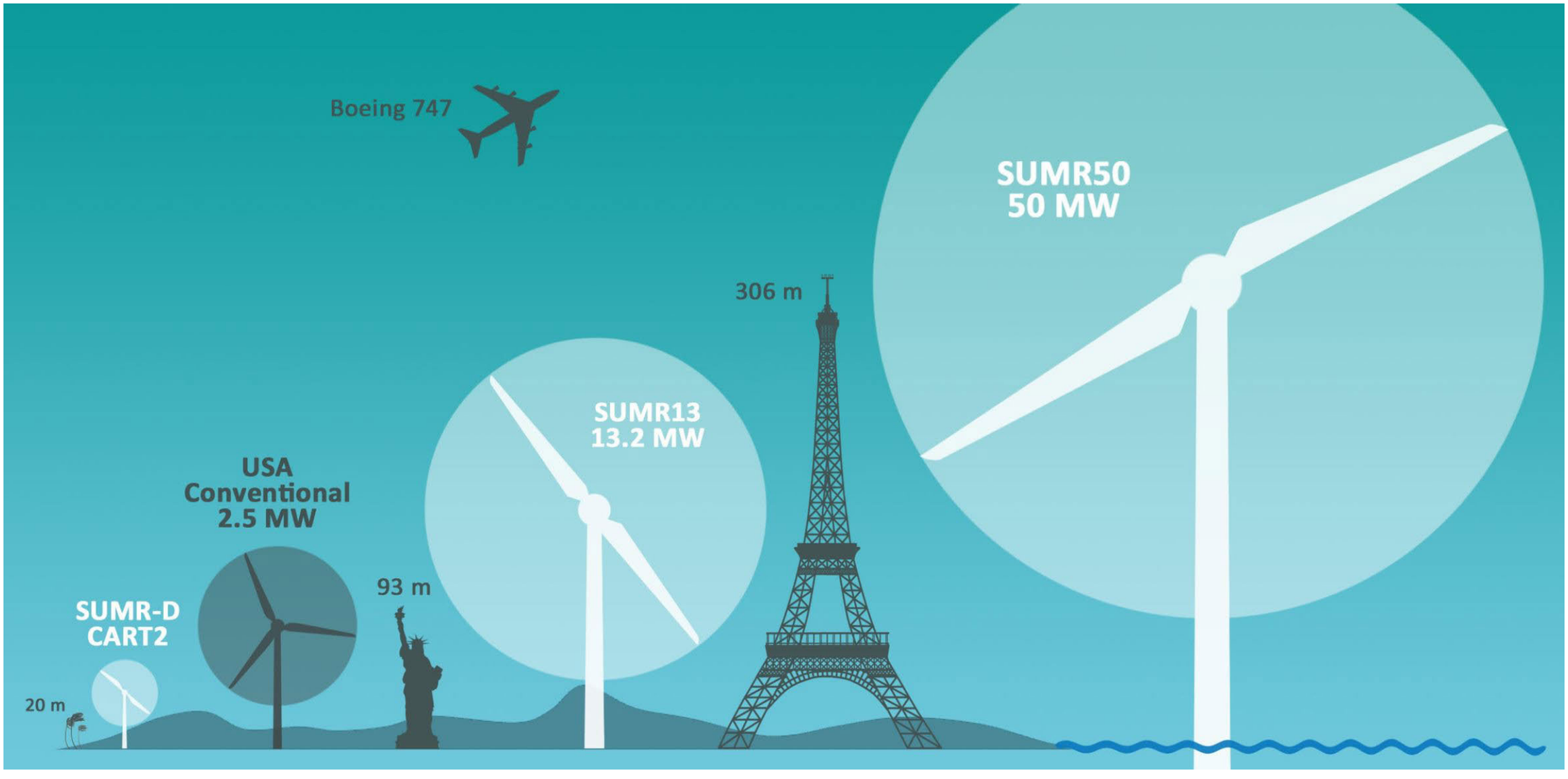
Neue Anlagenkonzepte? Bsp. Fa. aerodyn

Multirotor Windenergieanlagen? Bsp. Vestas

Neue Anlagenkonzepte? Bsp. US SUMR-Projekt

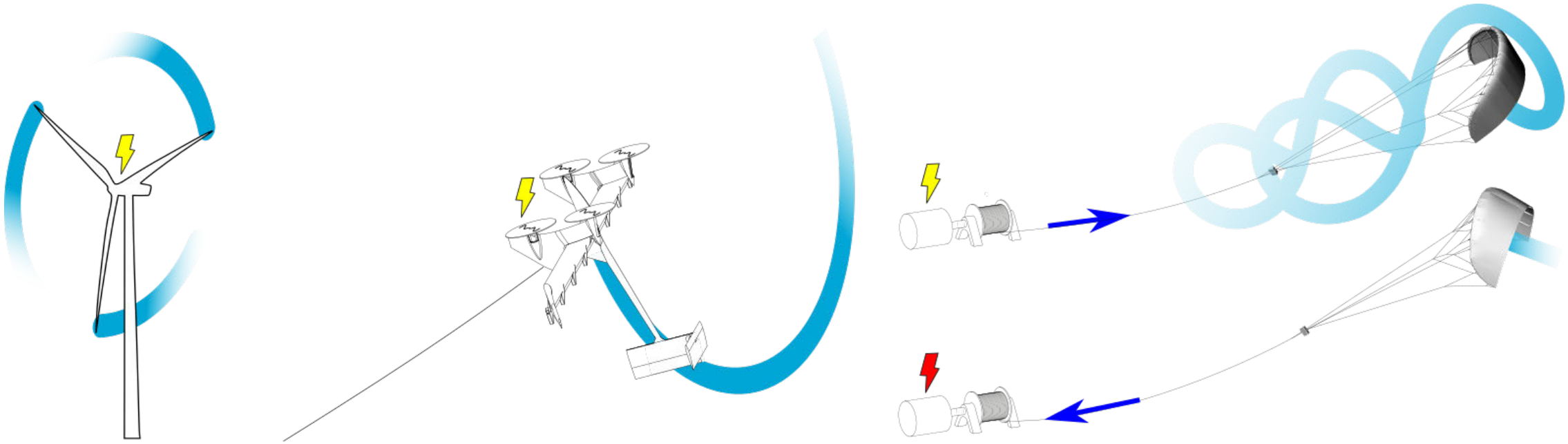


Neue Anlagenkonzepte? Bsp. US SUMR-Projekt



Airborne Wind Energy, e.g. Makani

Airborne Wind Energy



Picture: TU Delft, Roland Schmehl

Vielen Dank!