

Den Wind kontrollieren?

Wie Windenergieanlagen den Wind beeinflussen könn(t)en.

Dr. Stephan Barth

Windenergiesymposium AWES, 15.03.2018, Wien



Bundesweit führende Kooperationen

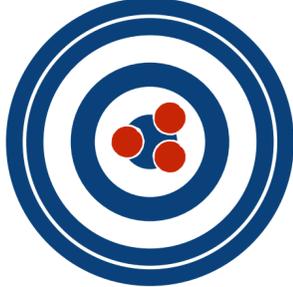


Forschungsverbund Windenergie



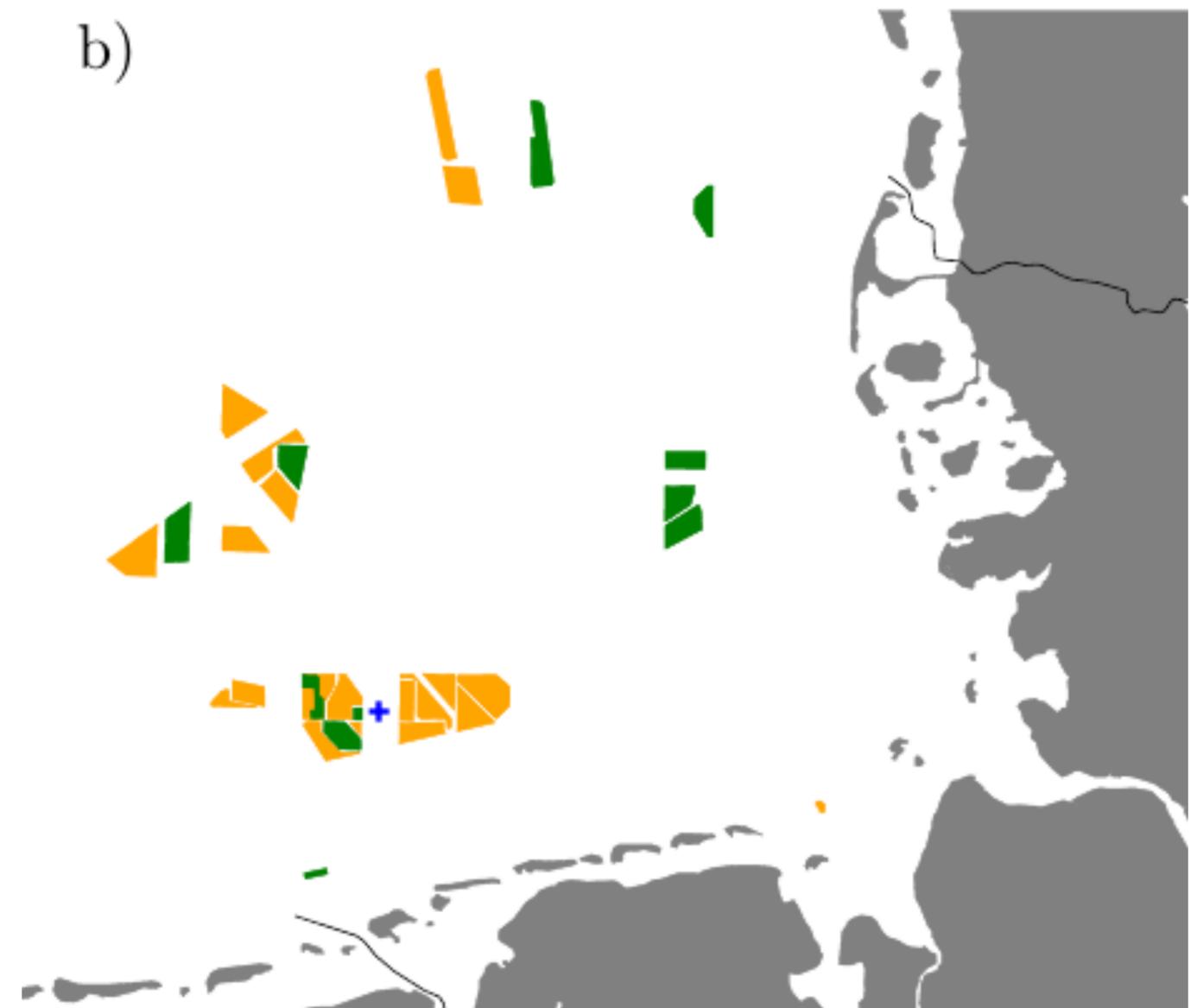
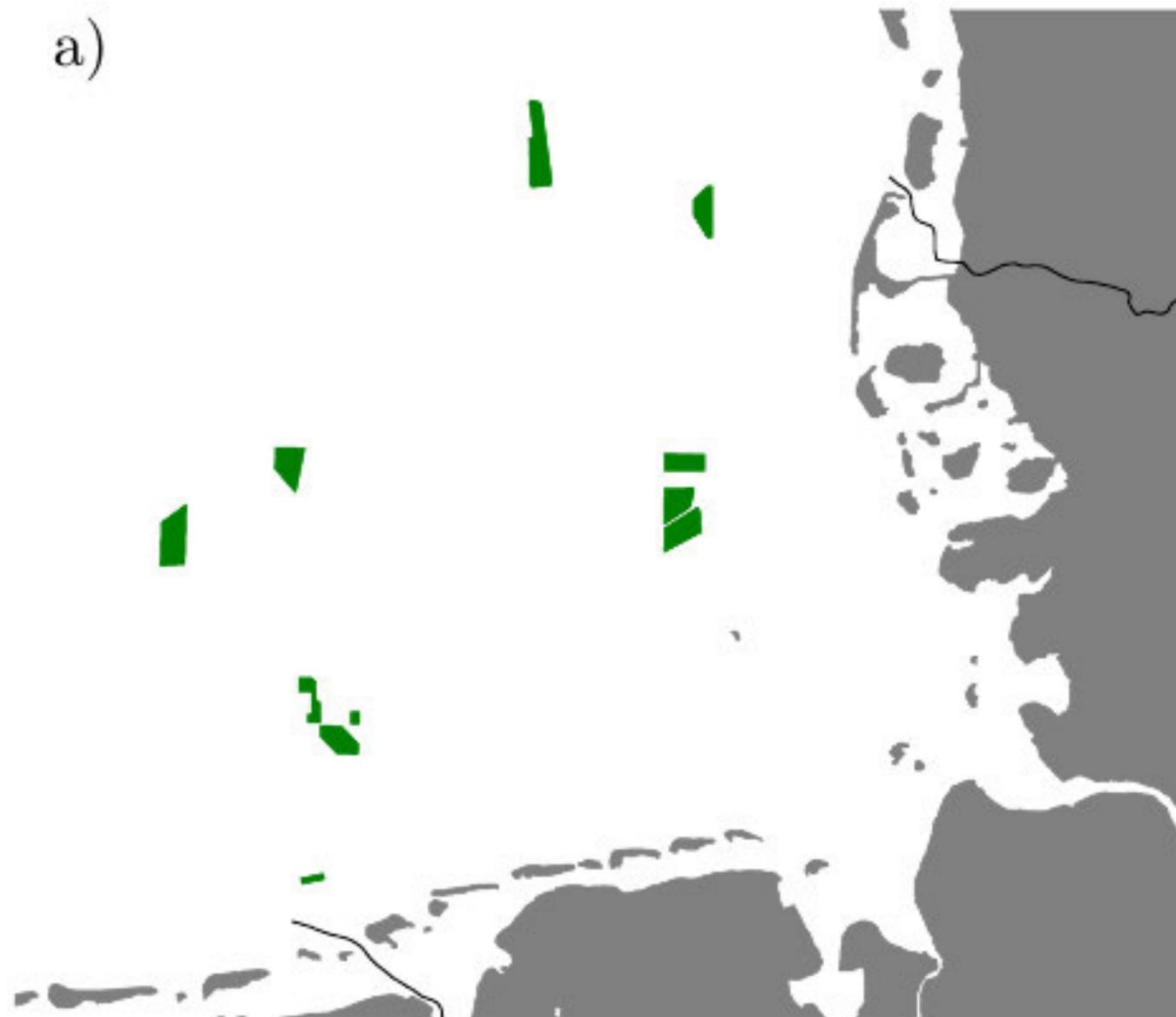
- 11 Standorte in 6 Bundesländern
- ca. 600 MitarbeiterInnen
 - DLR (6 Institute)
 - ForWind (28 Institute)
 - IWES Nordwest
- Kooperationsrahmenvertrag

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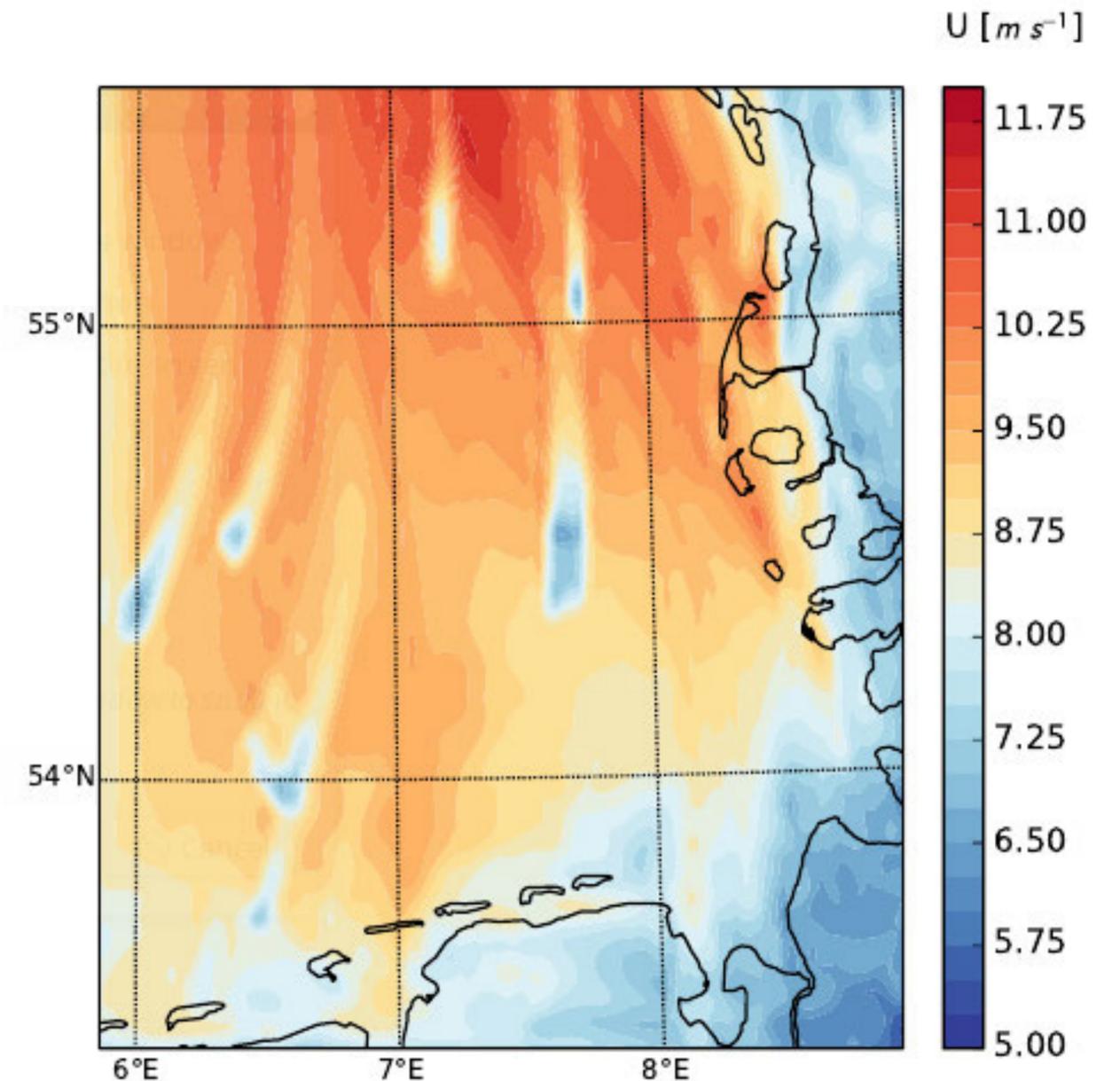
Wind auf See in der Deutschen Bucht

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



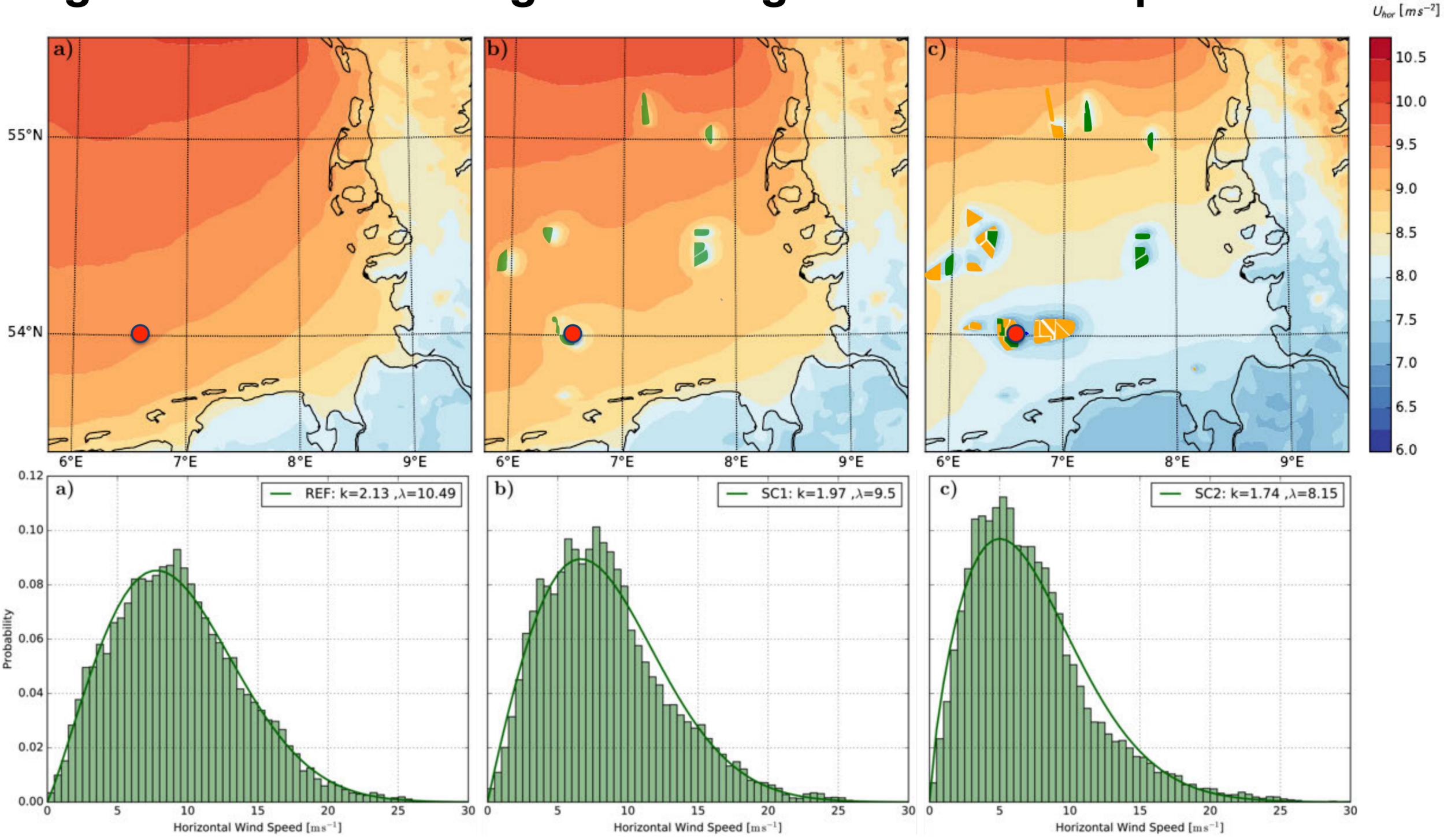
Fluktuierende Windfelder

- 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!

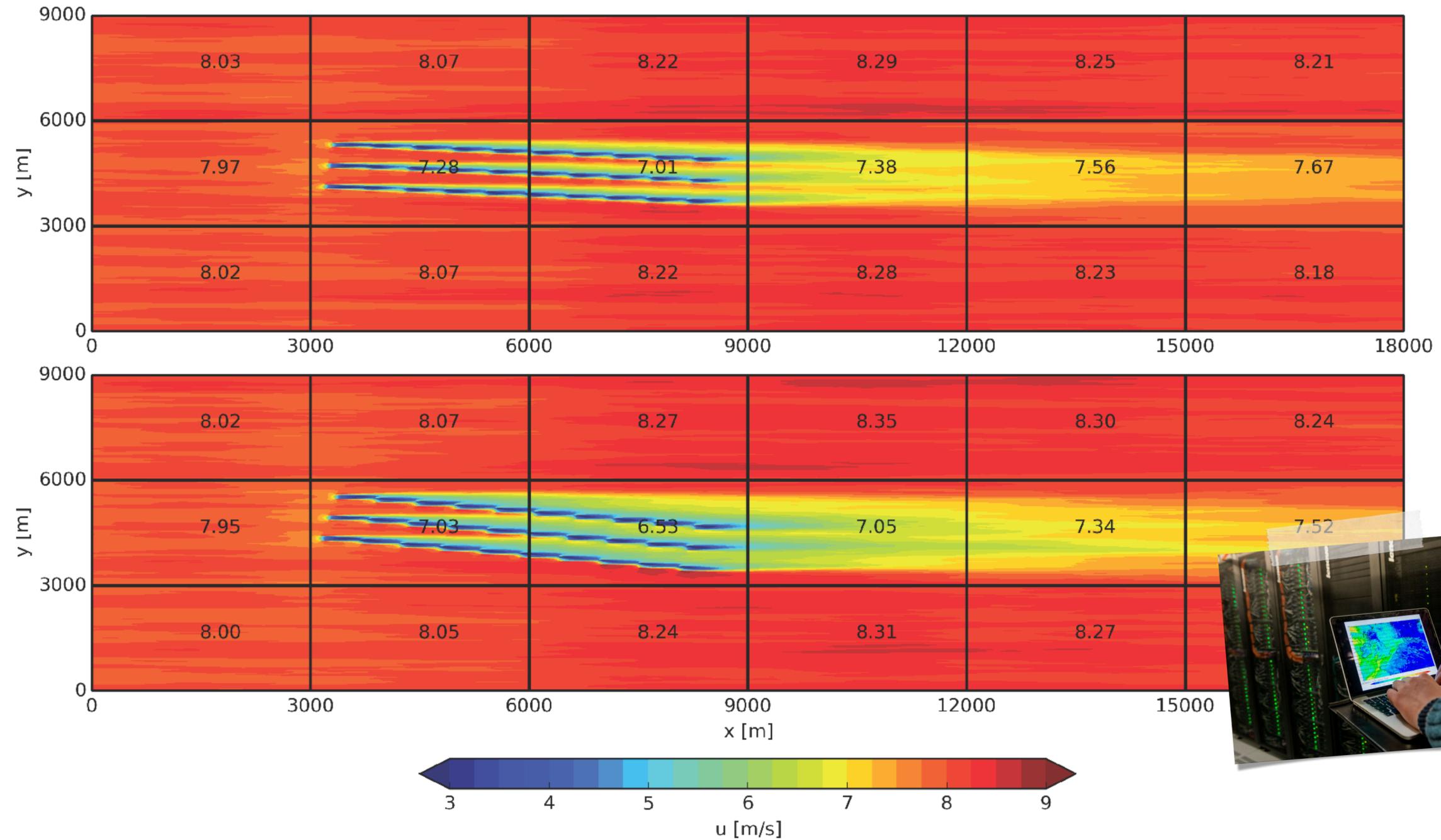


Instantaneous wind field at hub height (SC1) on 28.10.2011 – 03:00 UTC during southwesterly winds

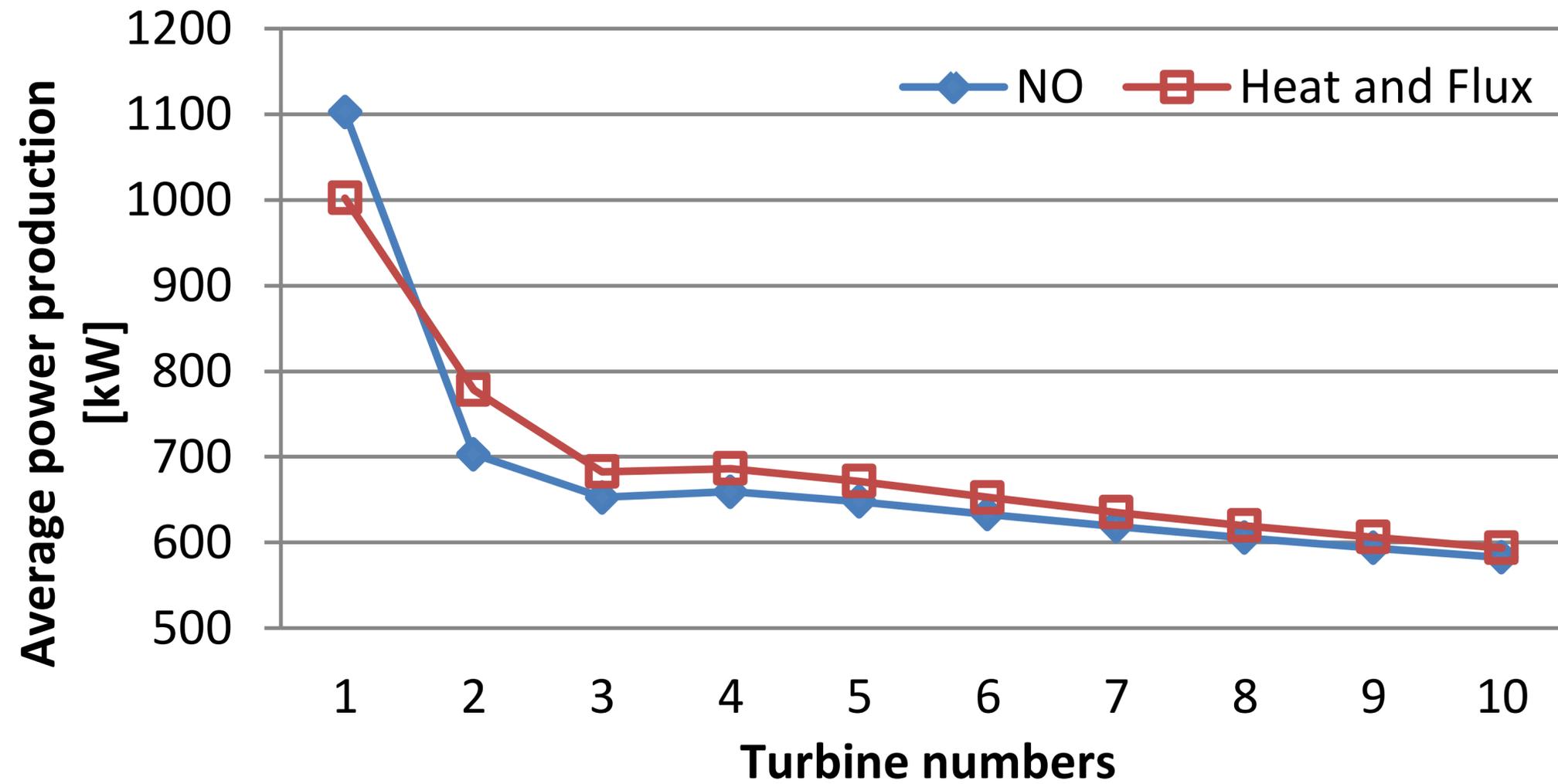
Reduzierung der mittleren Windgeschwindigkeit durch Windparks



Limitierungen in der Genauigkeit

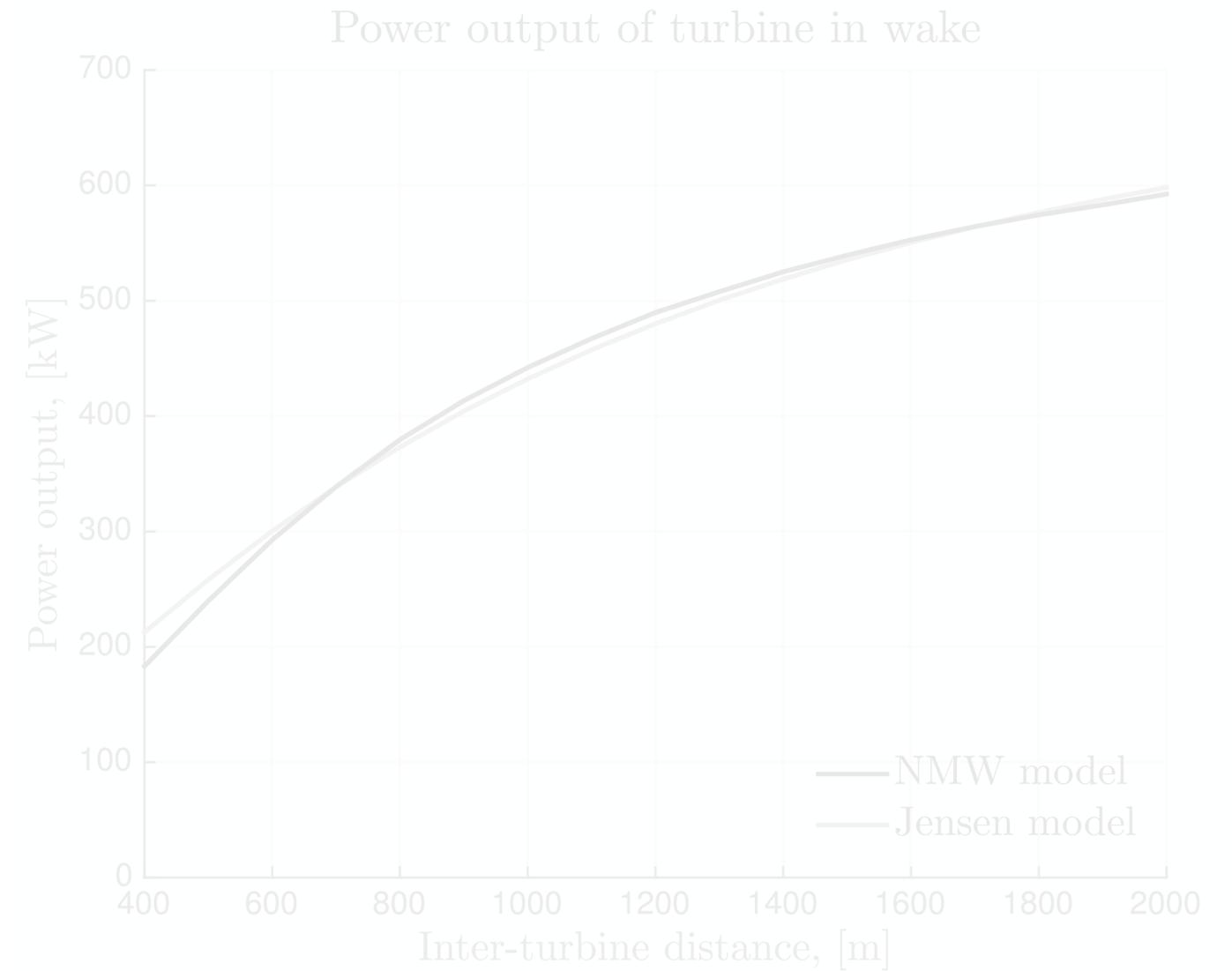
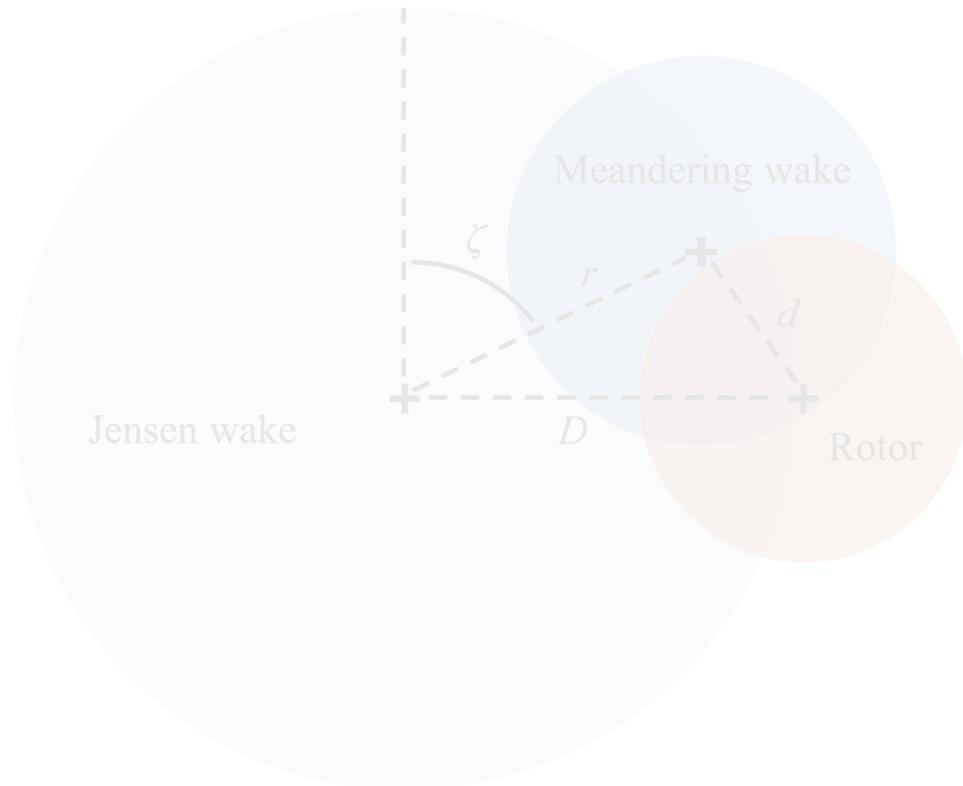
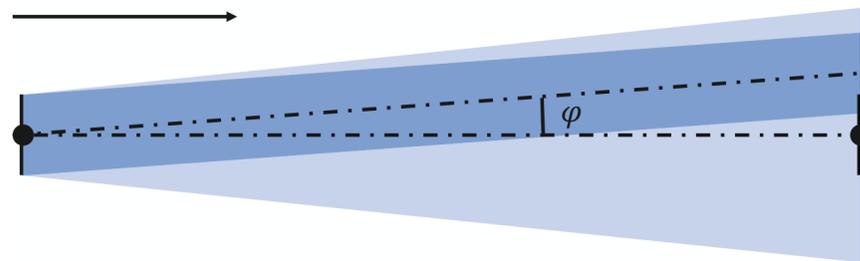


Windparkregelung durch Schubanpassung?



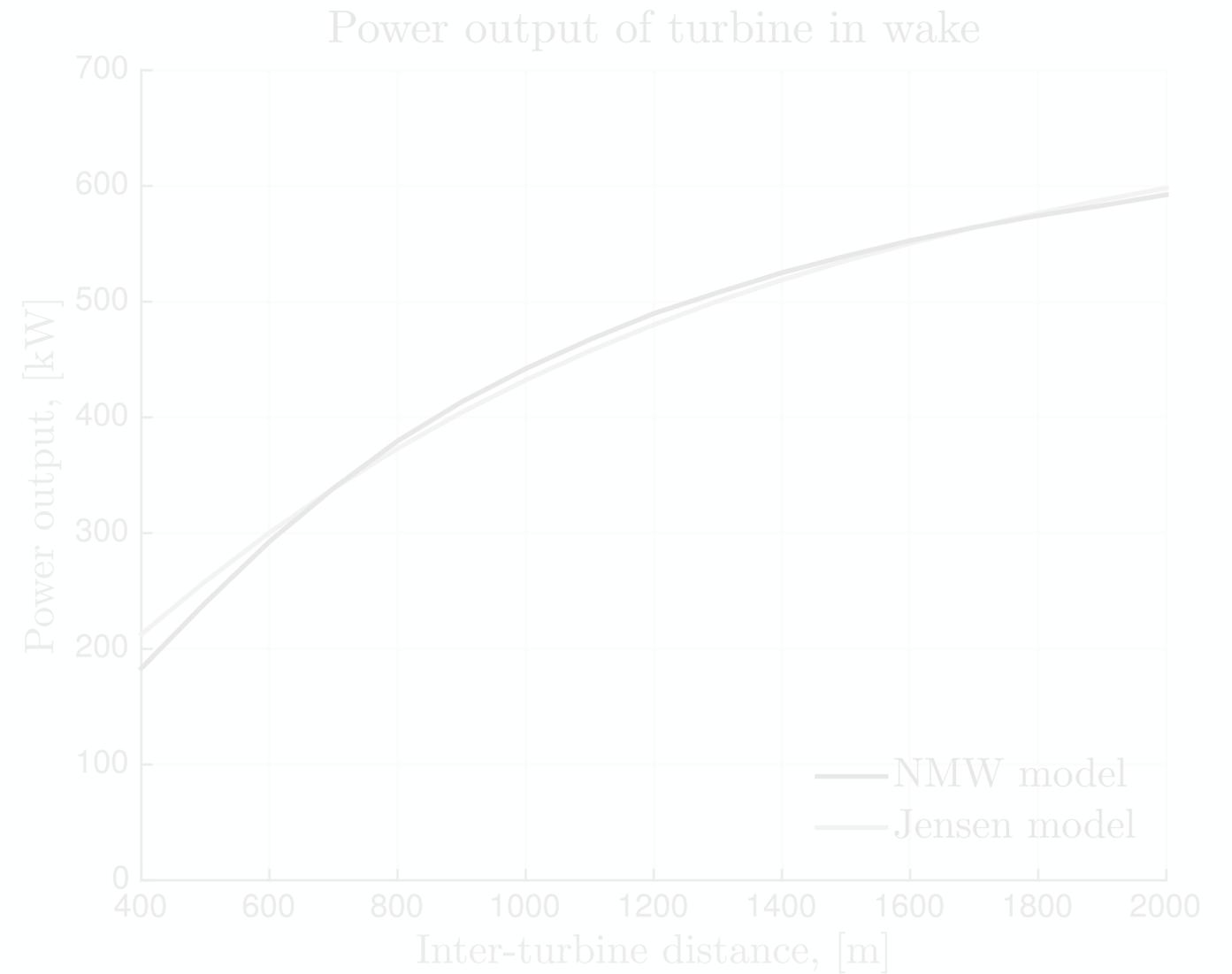
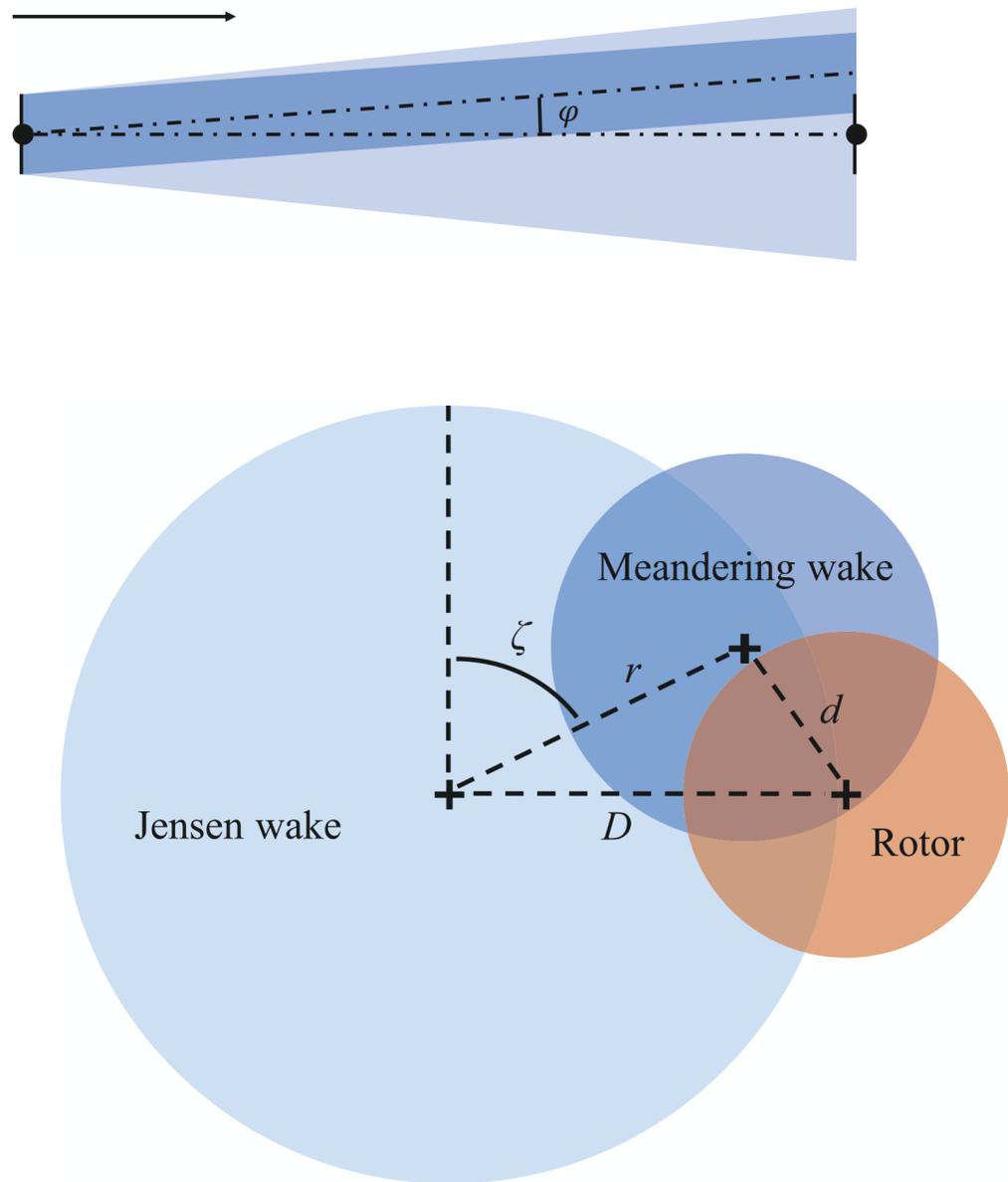
E.T.G Bot et al. | ECN | Journal of Physics: Conference Series 555 (2014) 012061 doi:10.1088/1742-6596/555/1/012061

Sind die Grundannahmen richtig?



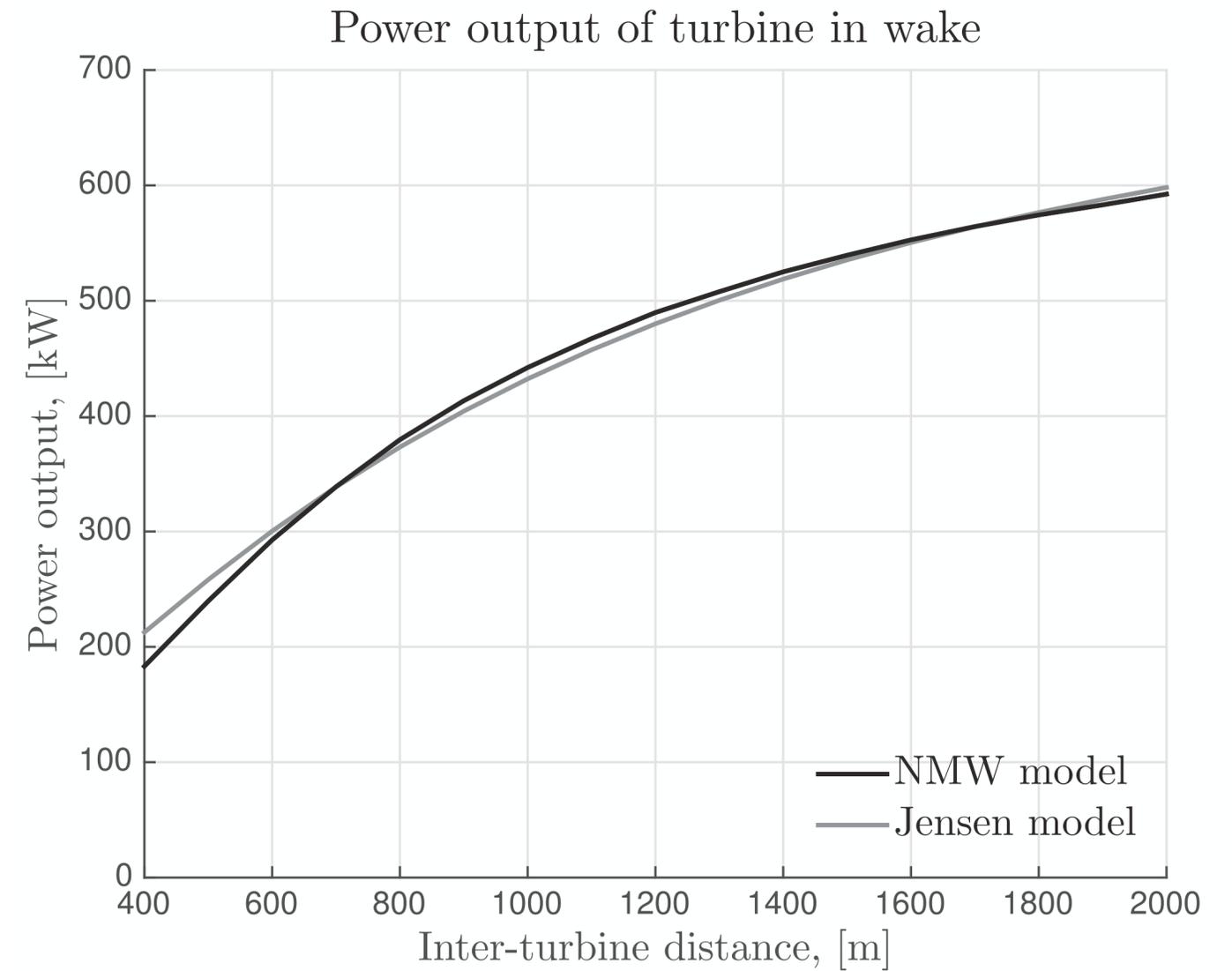
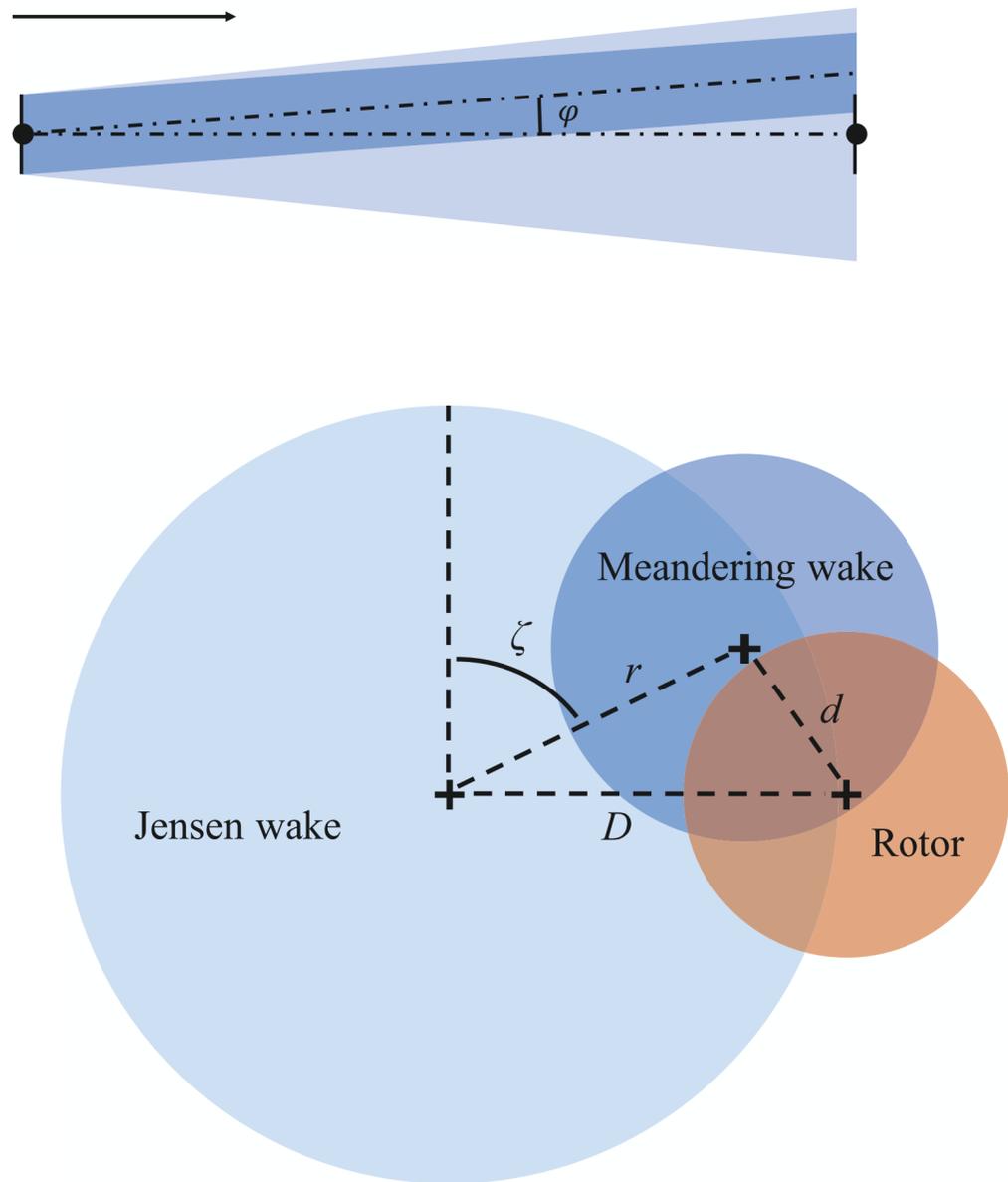
M. Greiner et al. | Aarhus University | IOP Conf. Series: Journal of Physics: Conf. Series 1825344(526071879)012017 doi:10.1088/1742-6596/854/1/012017

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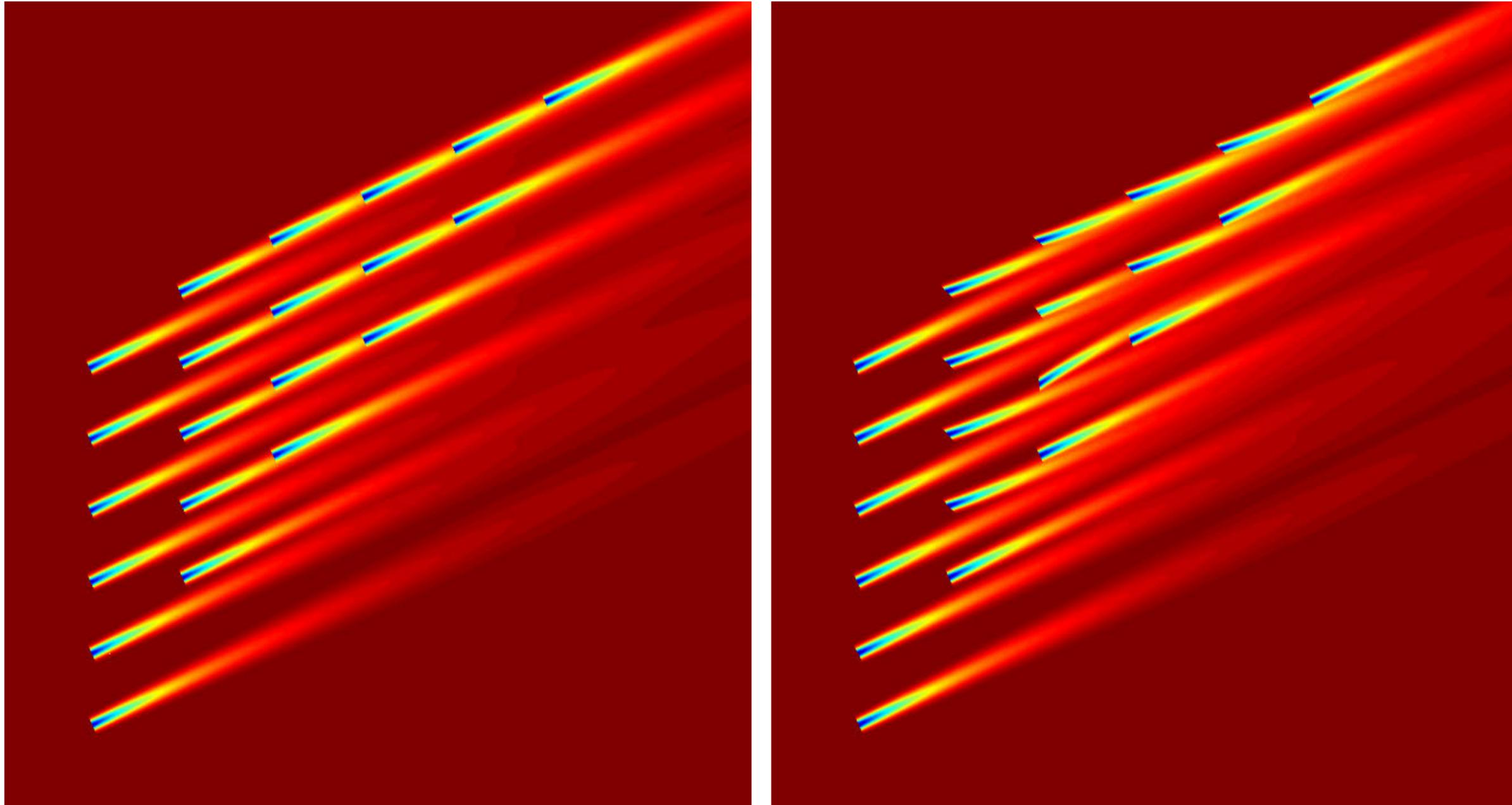
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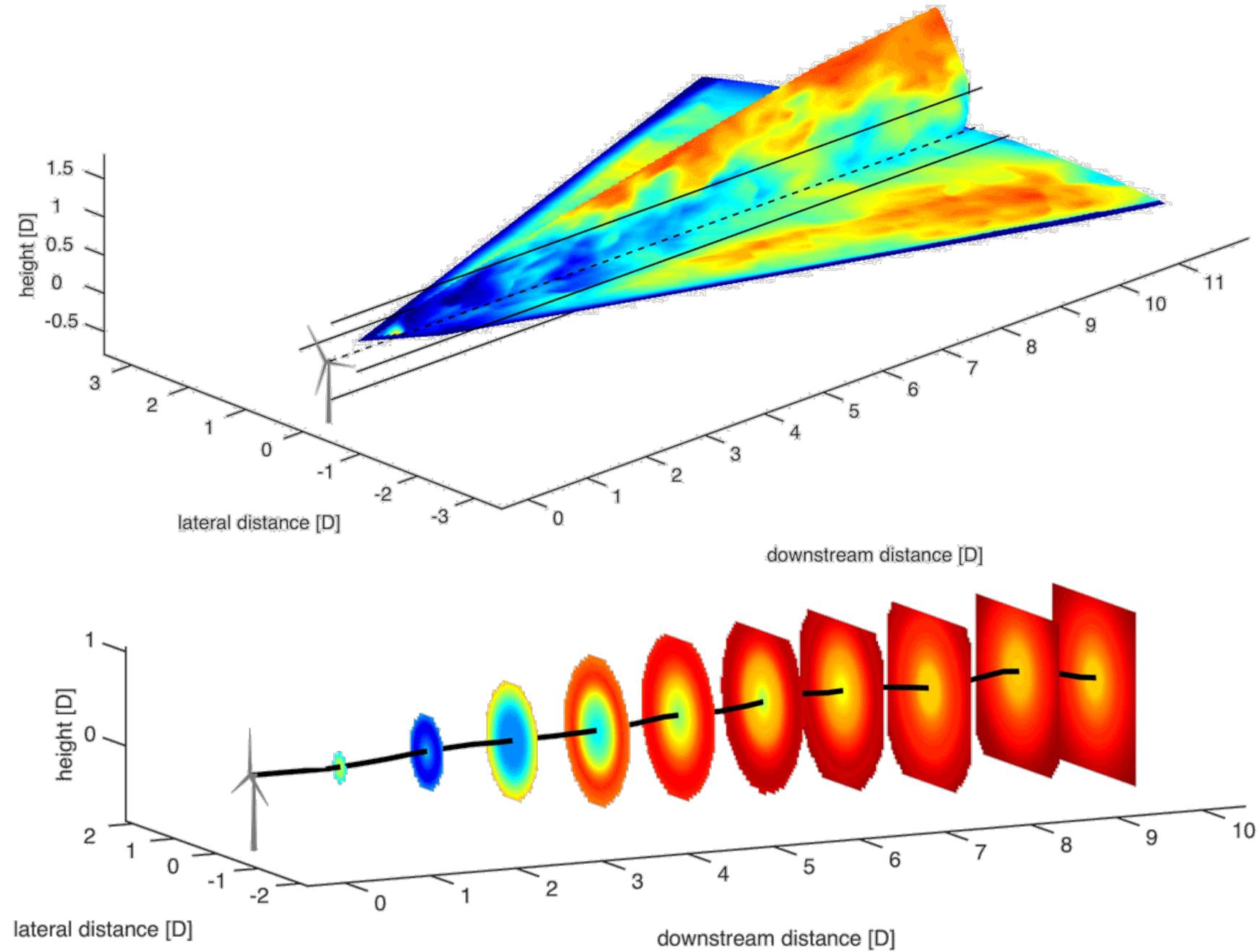


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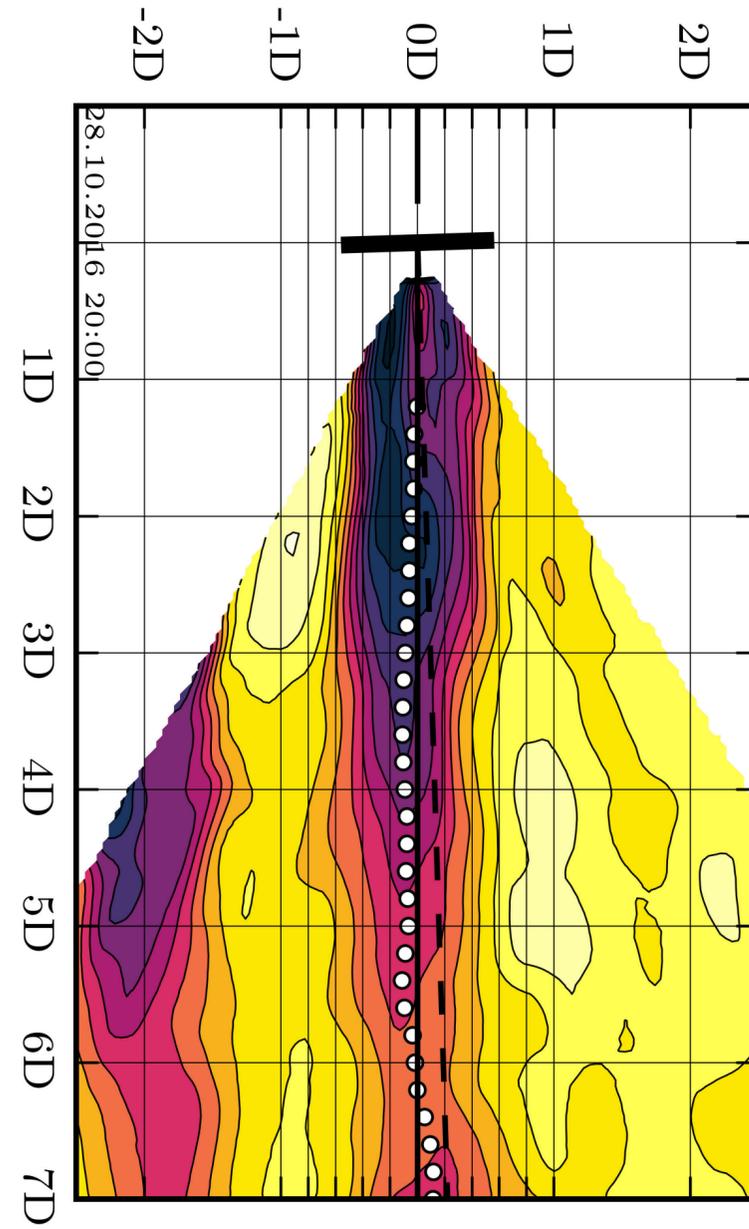
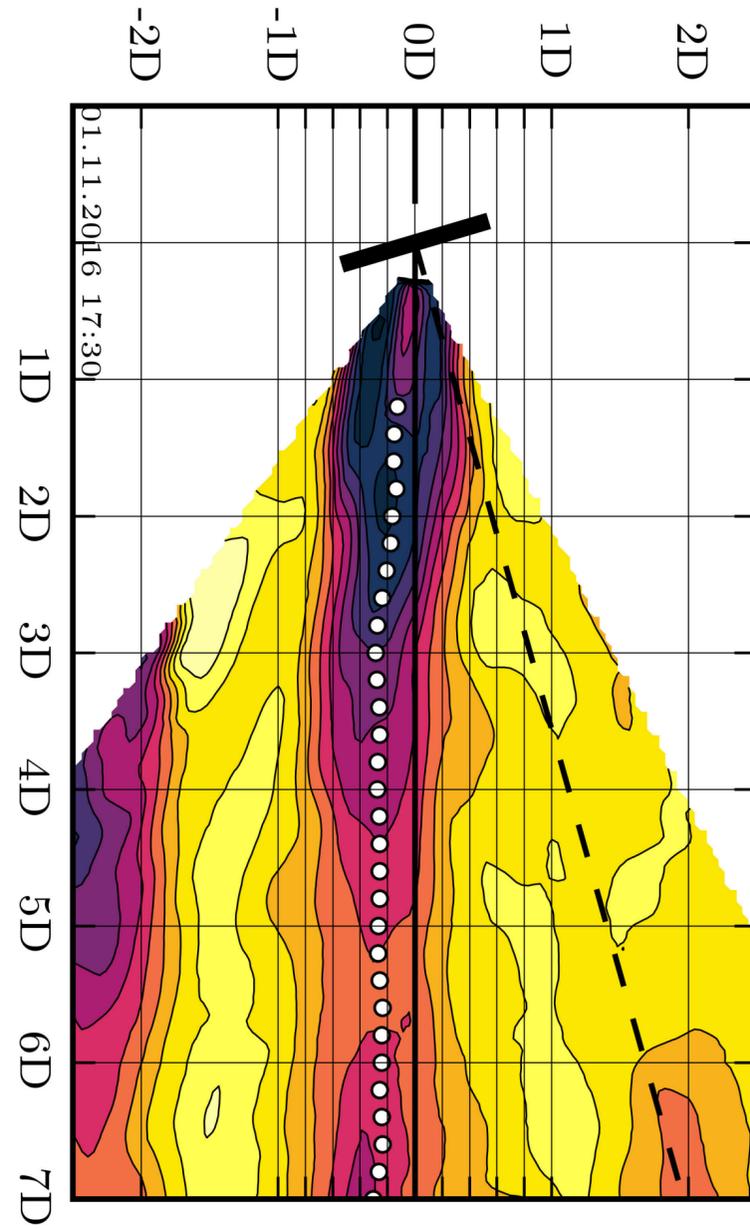
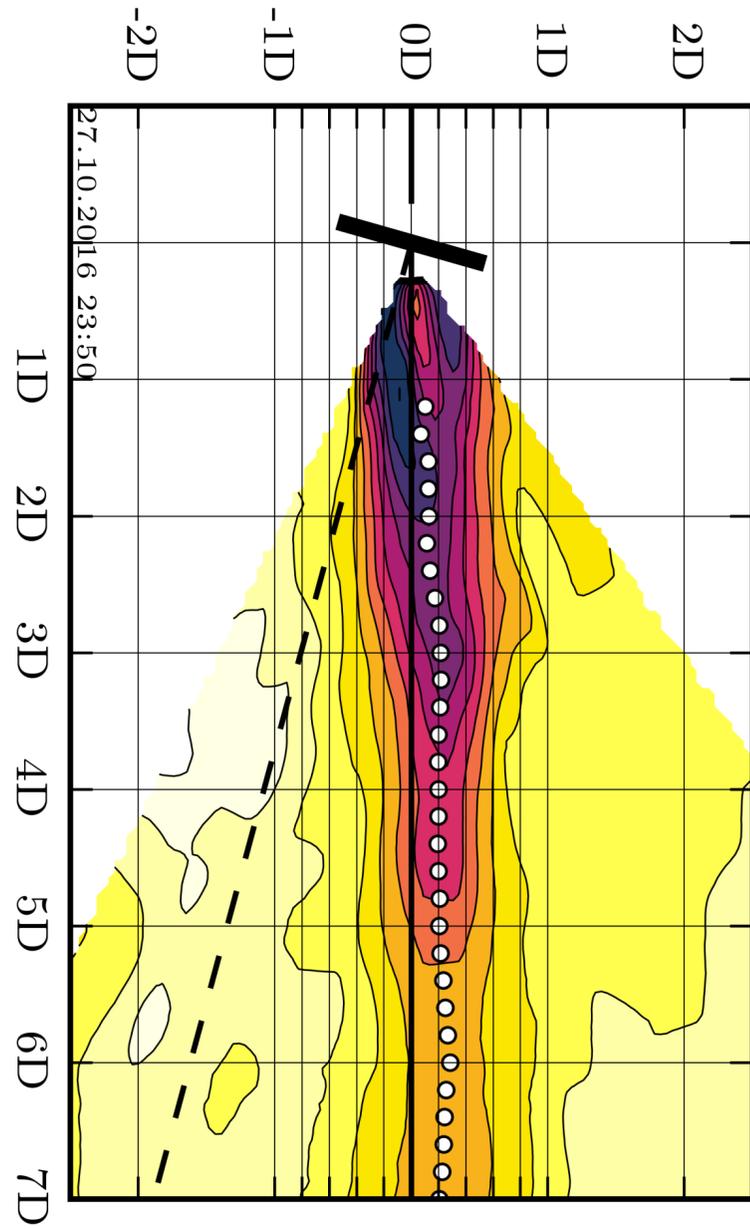
Ist eine aktive Nachlaufablenkung das bessere Konzept?



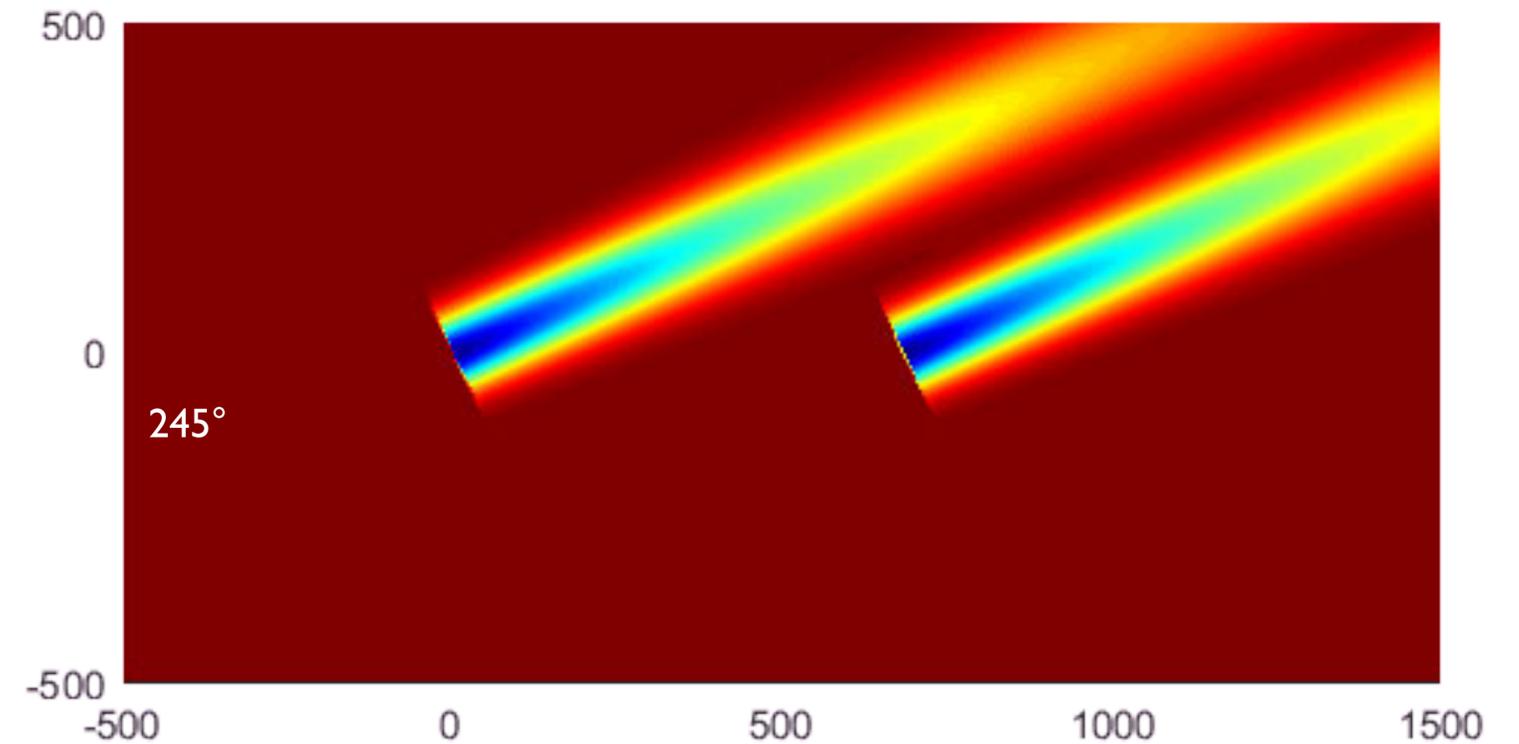
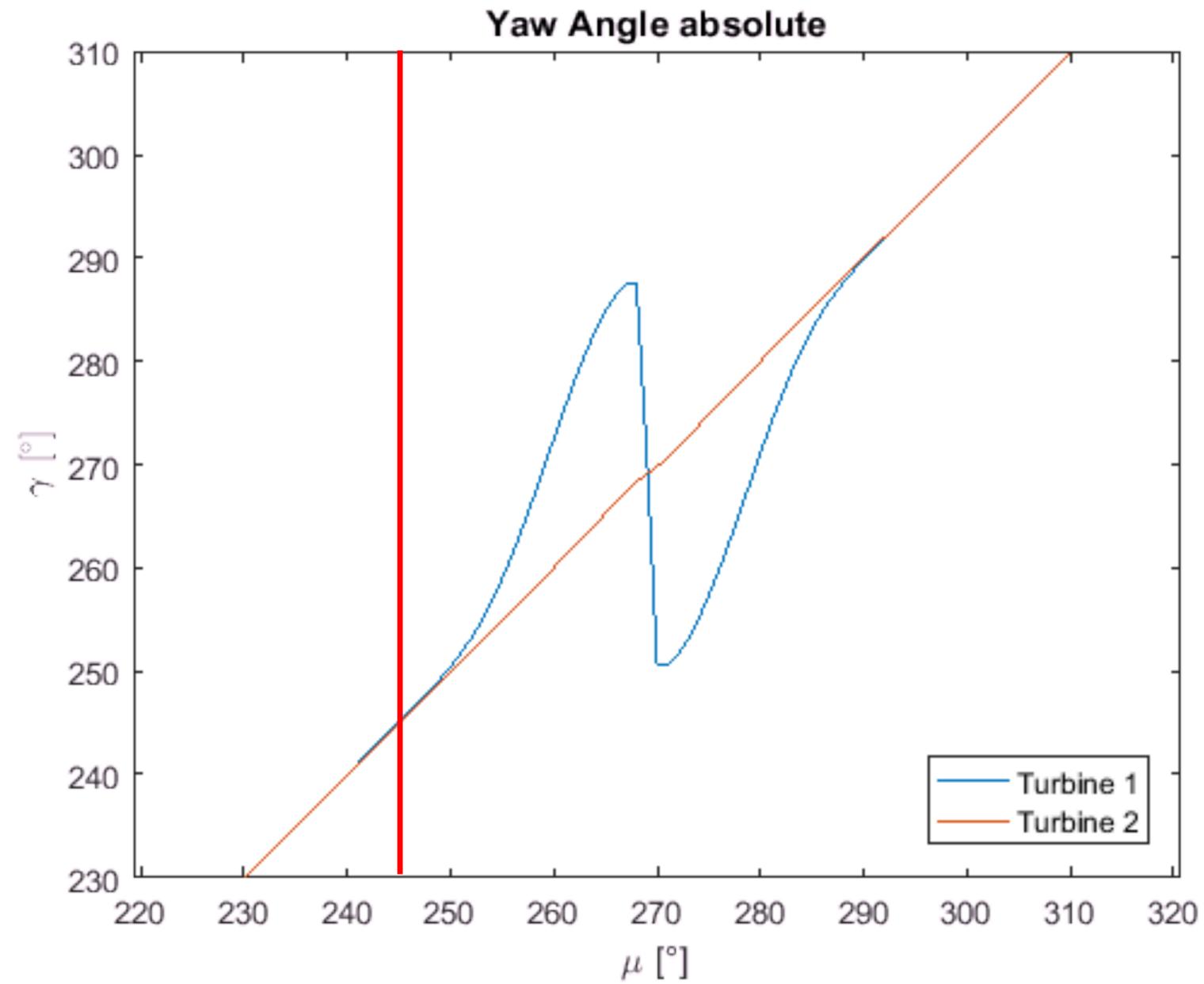
Untersuchung des Nachlaufverhaltens mit LIDAR möglich



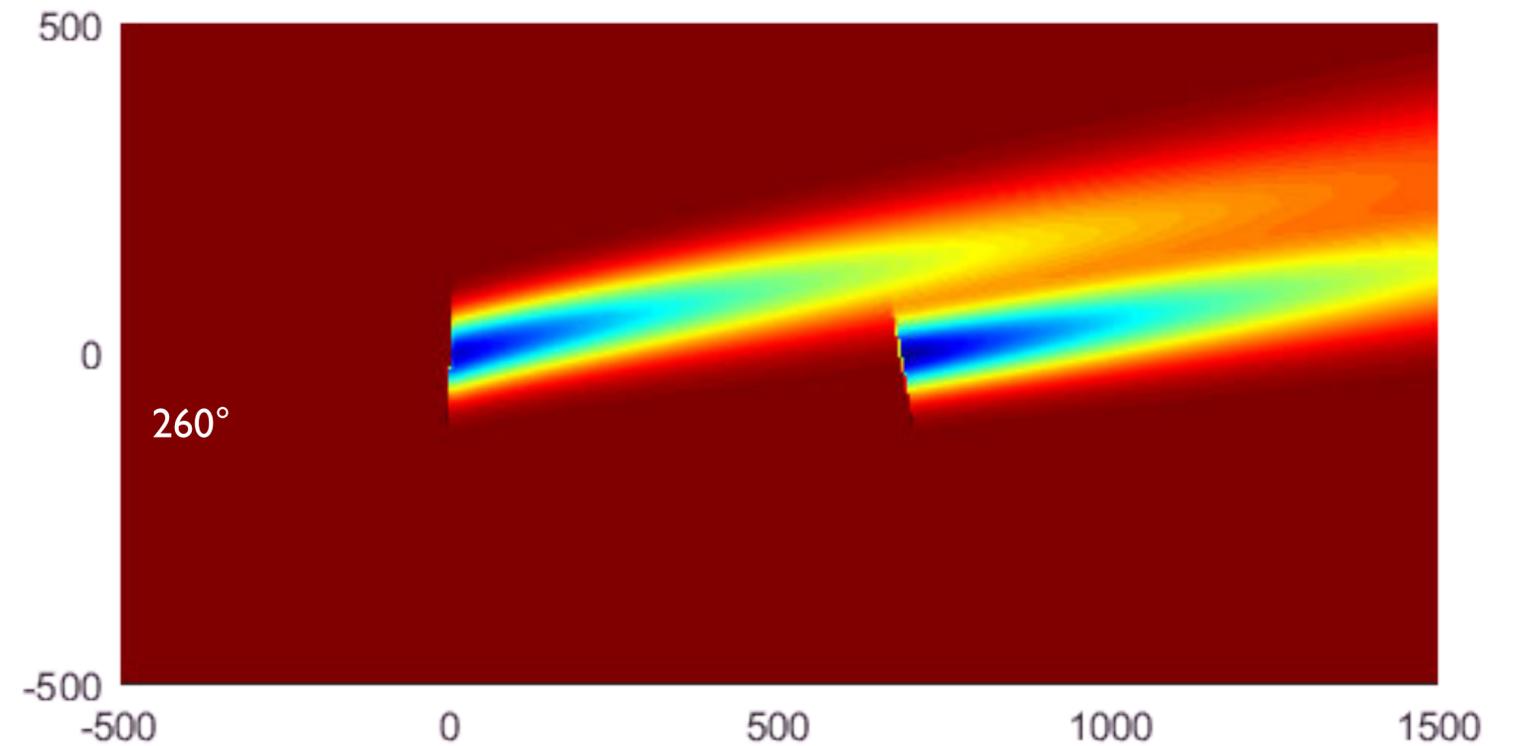
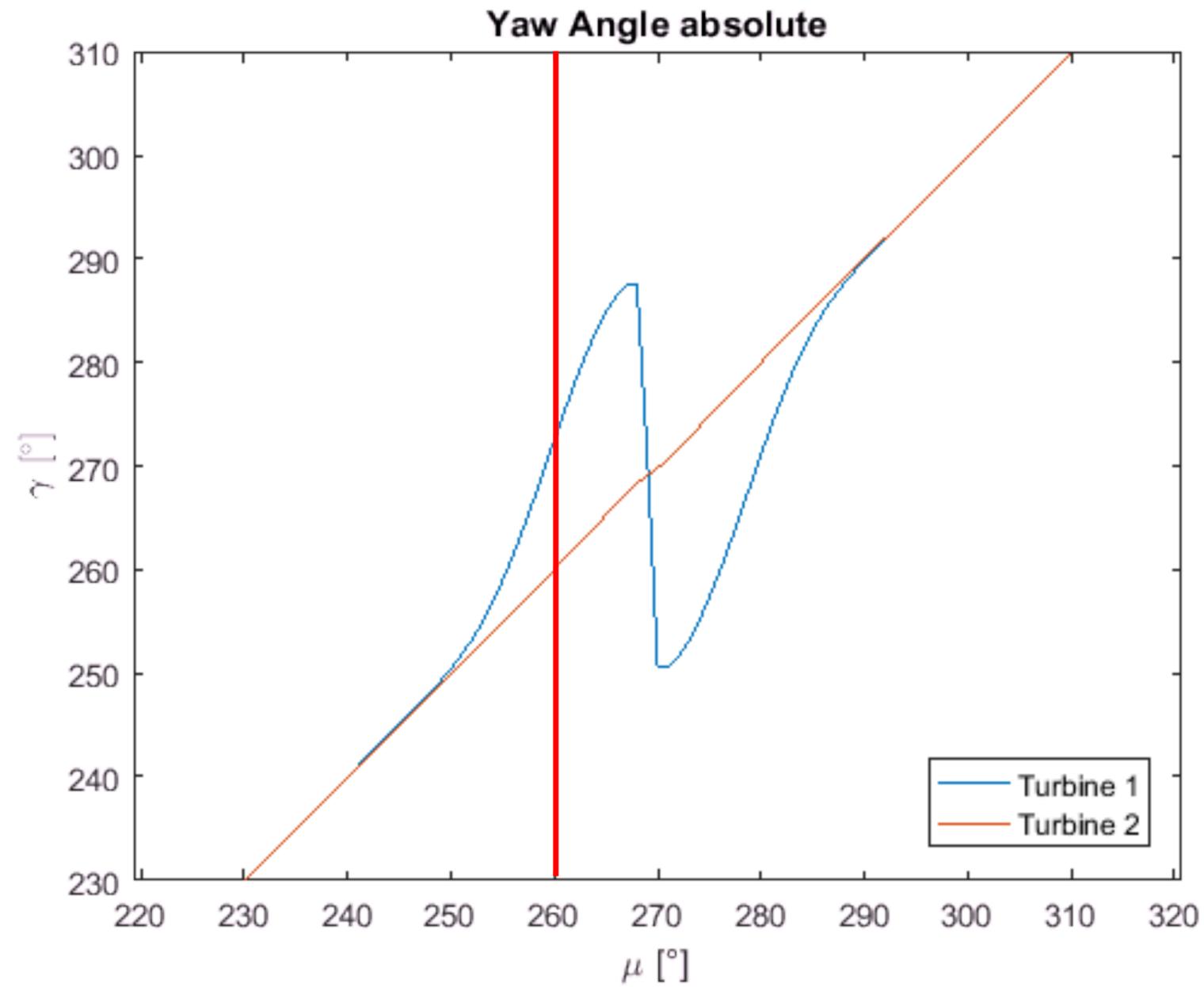
Ablenkung des Nachlaufs durch Schiefstellung



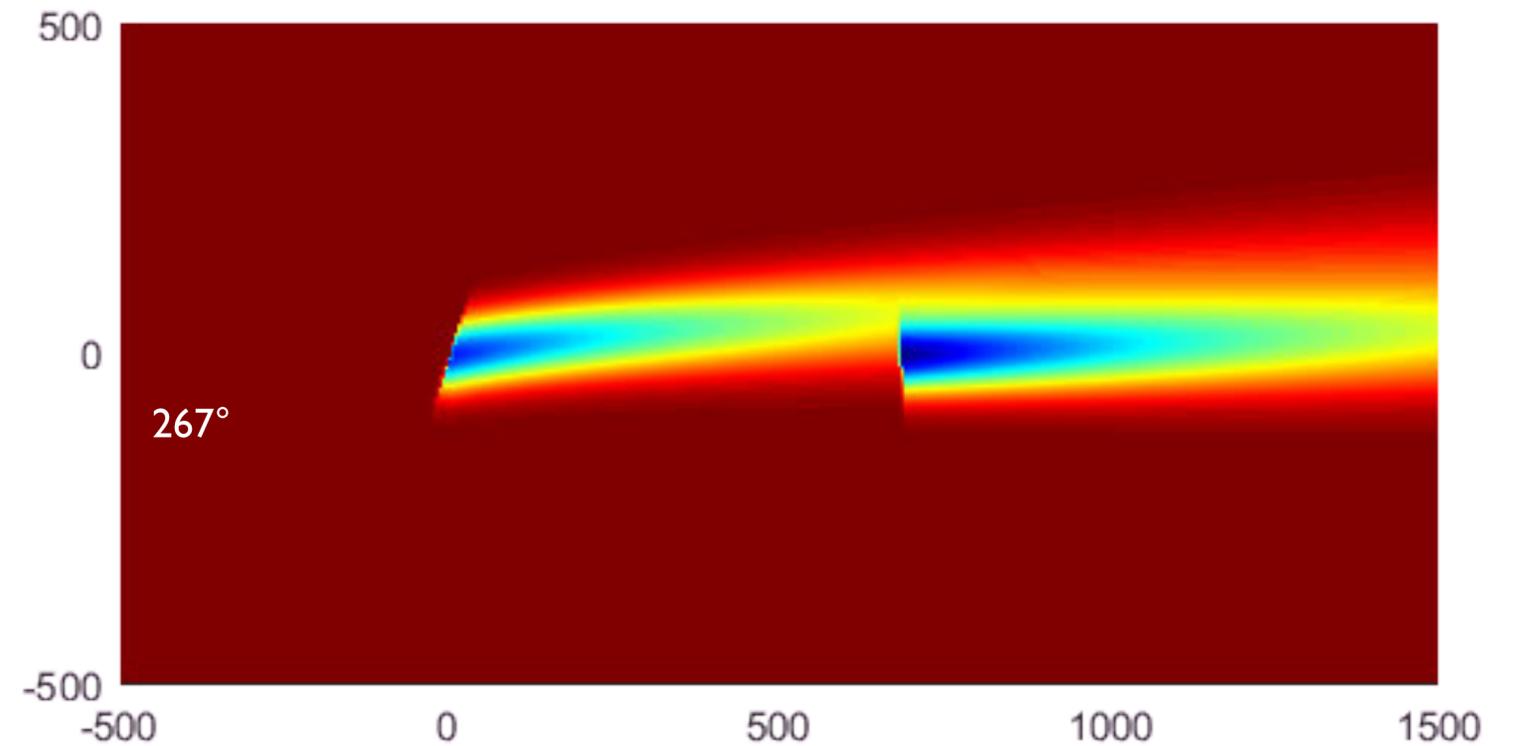
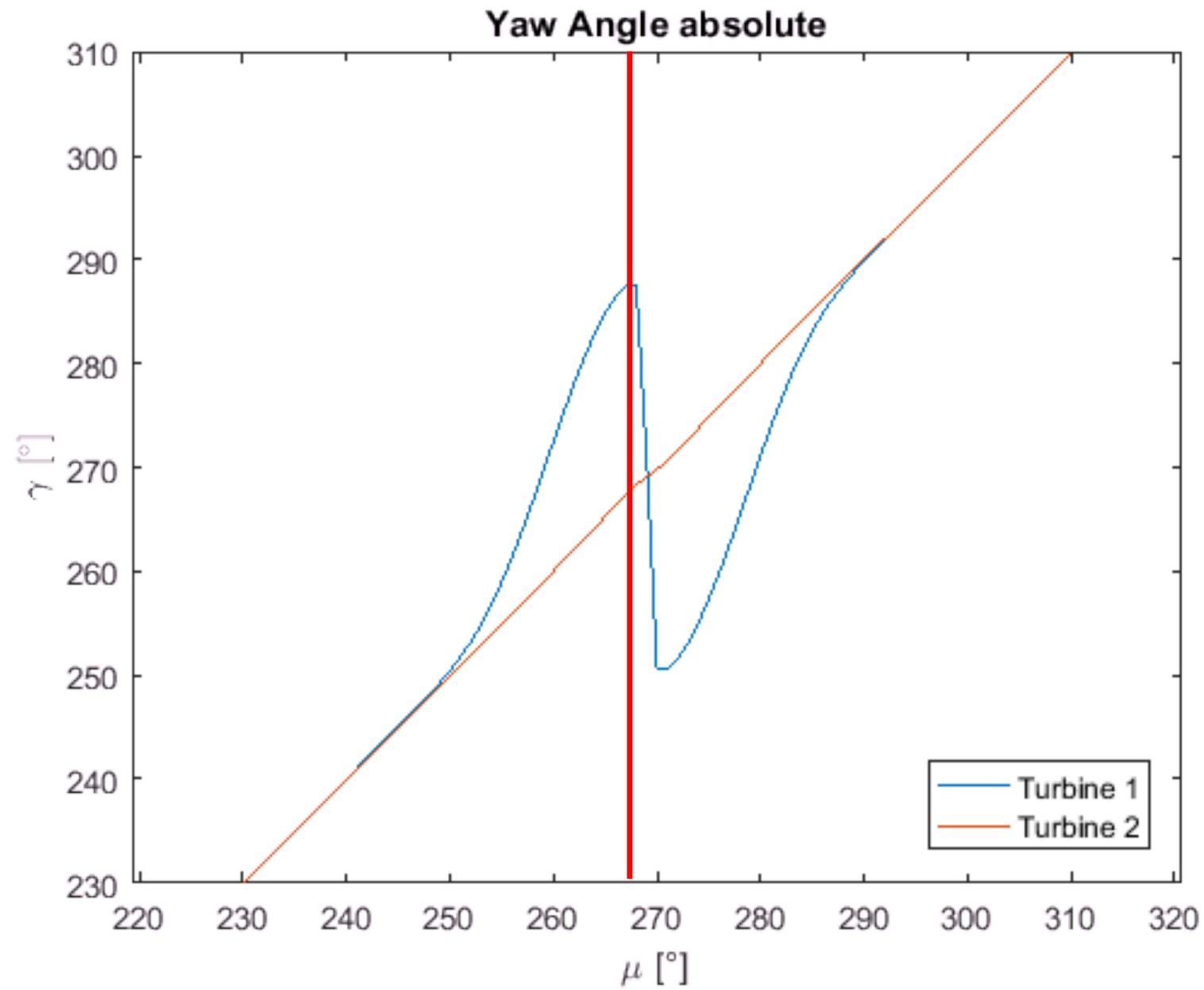
Nachlaufablenkung in der Anwendung



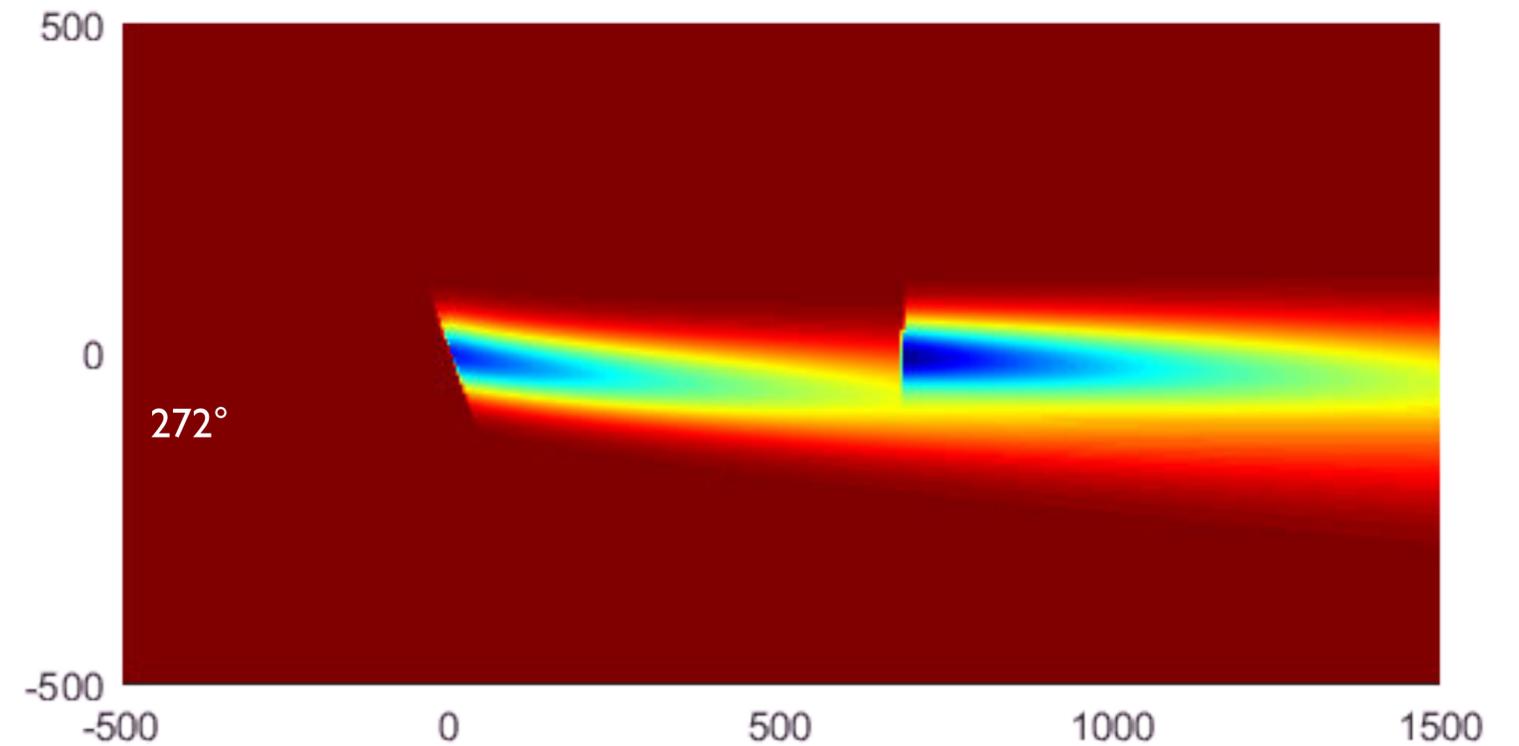
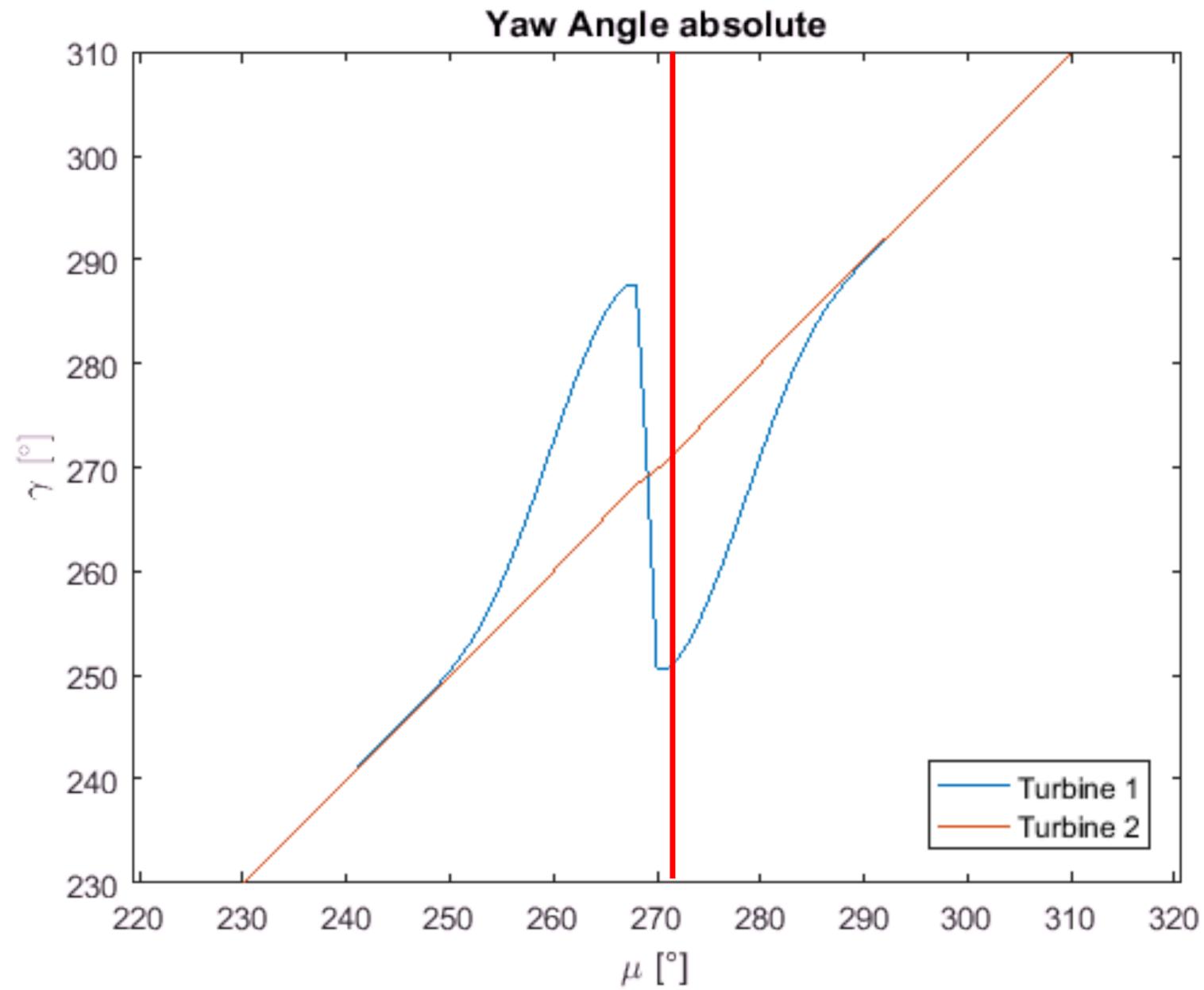
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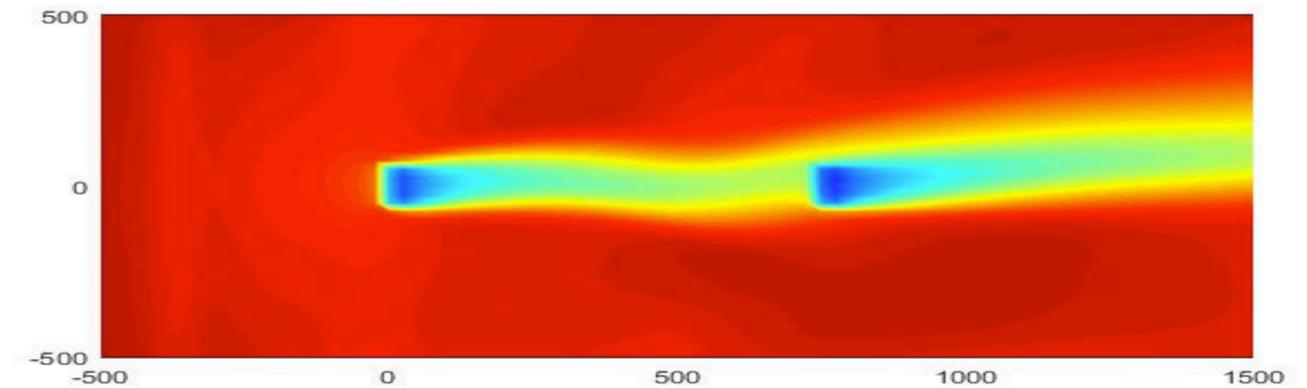
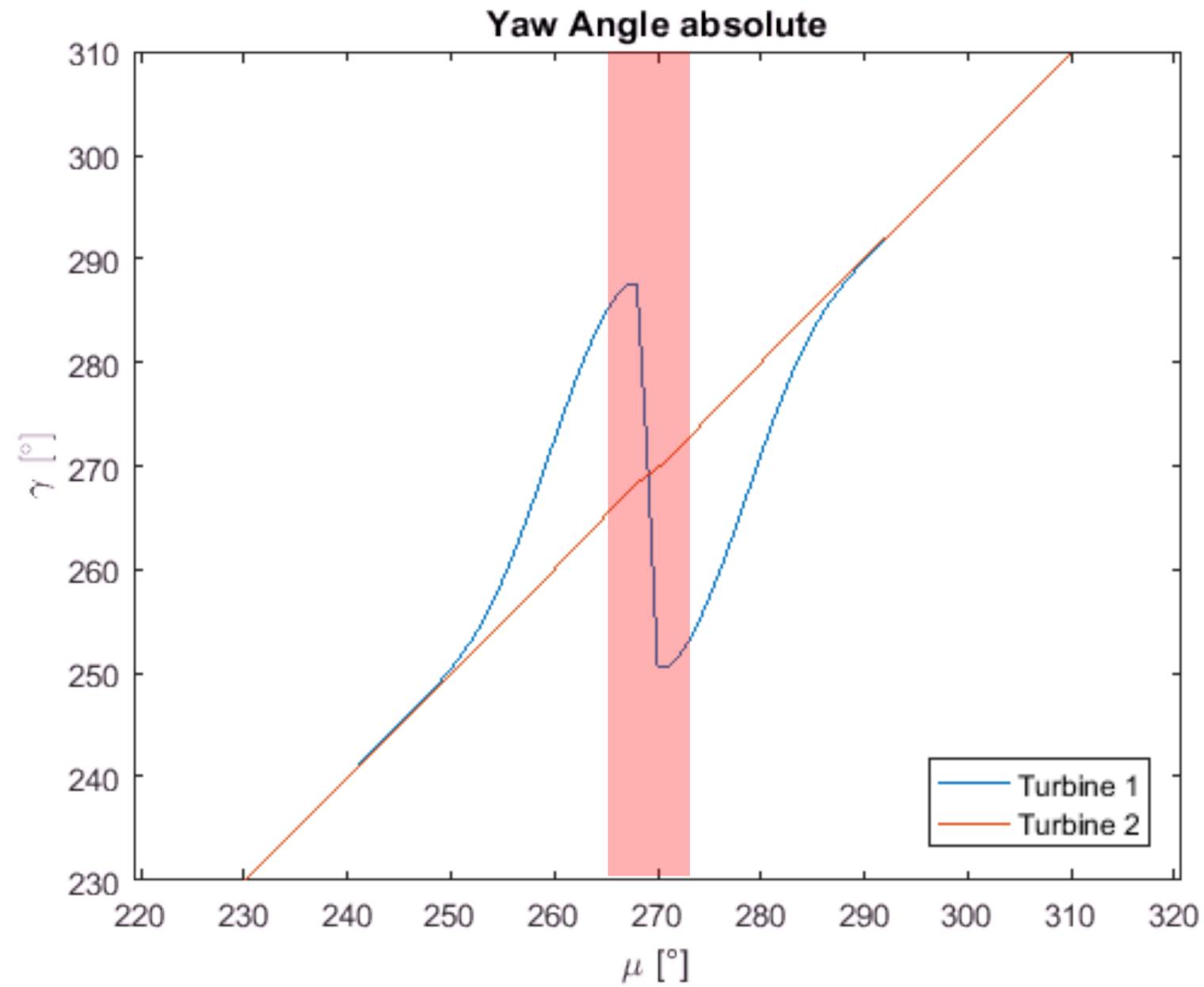
Nachlaufablenkung in der Anwendung



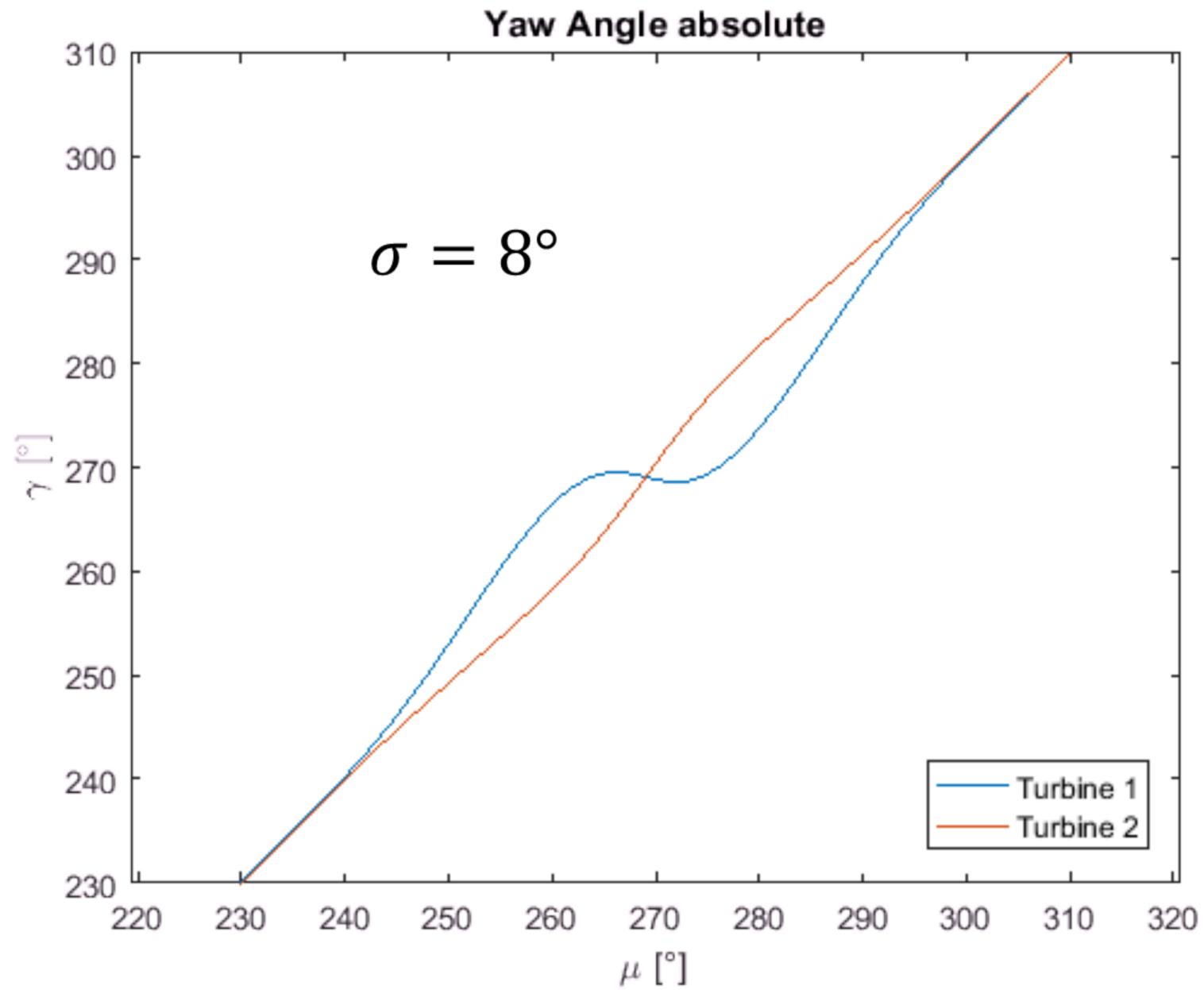
Nachlaufablenkung in der Anwendung



Ertragssteigerung ohne Nachteile auf der Lastenseite



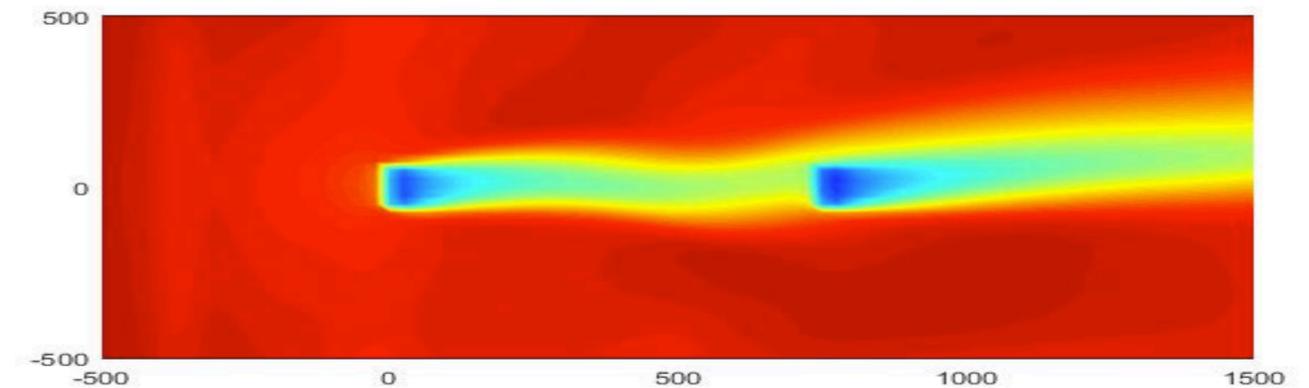
Robuste Optimierung



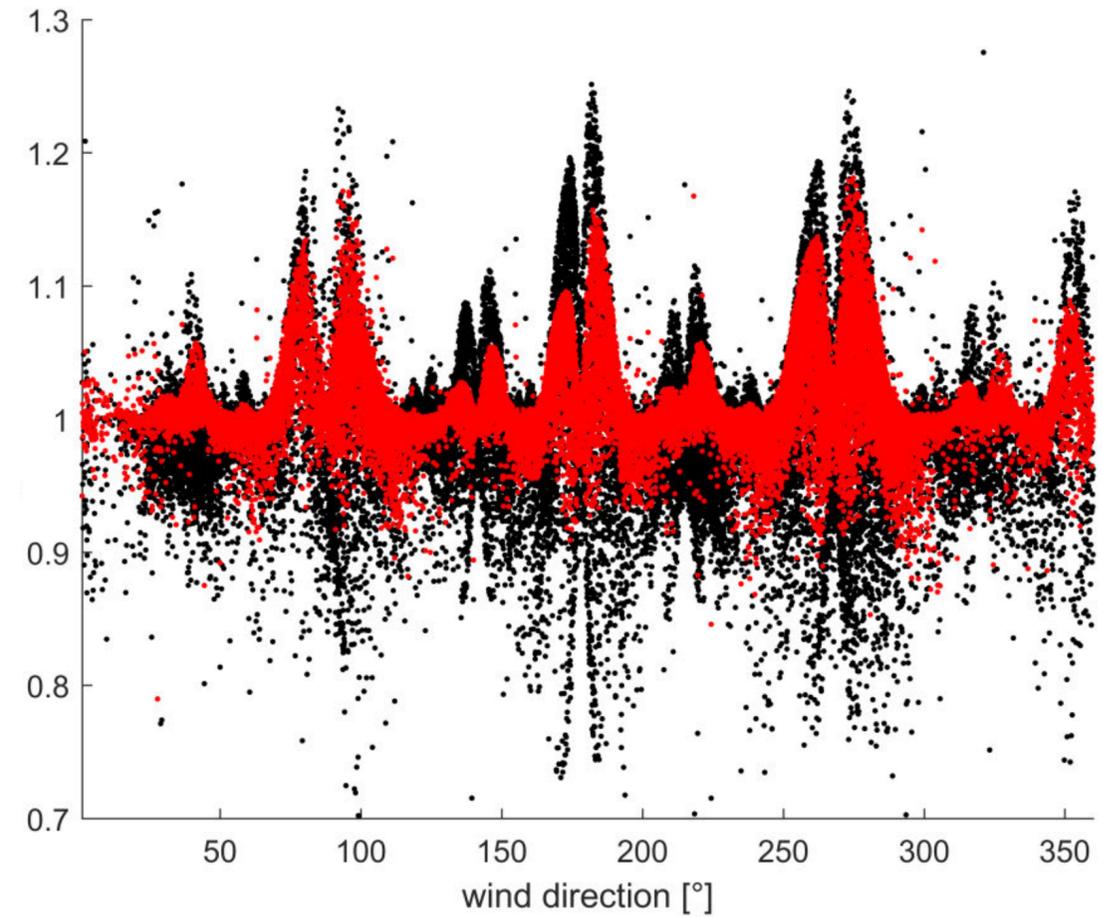
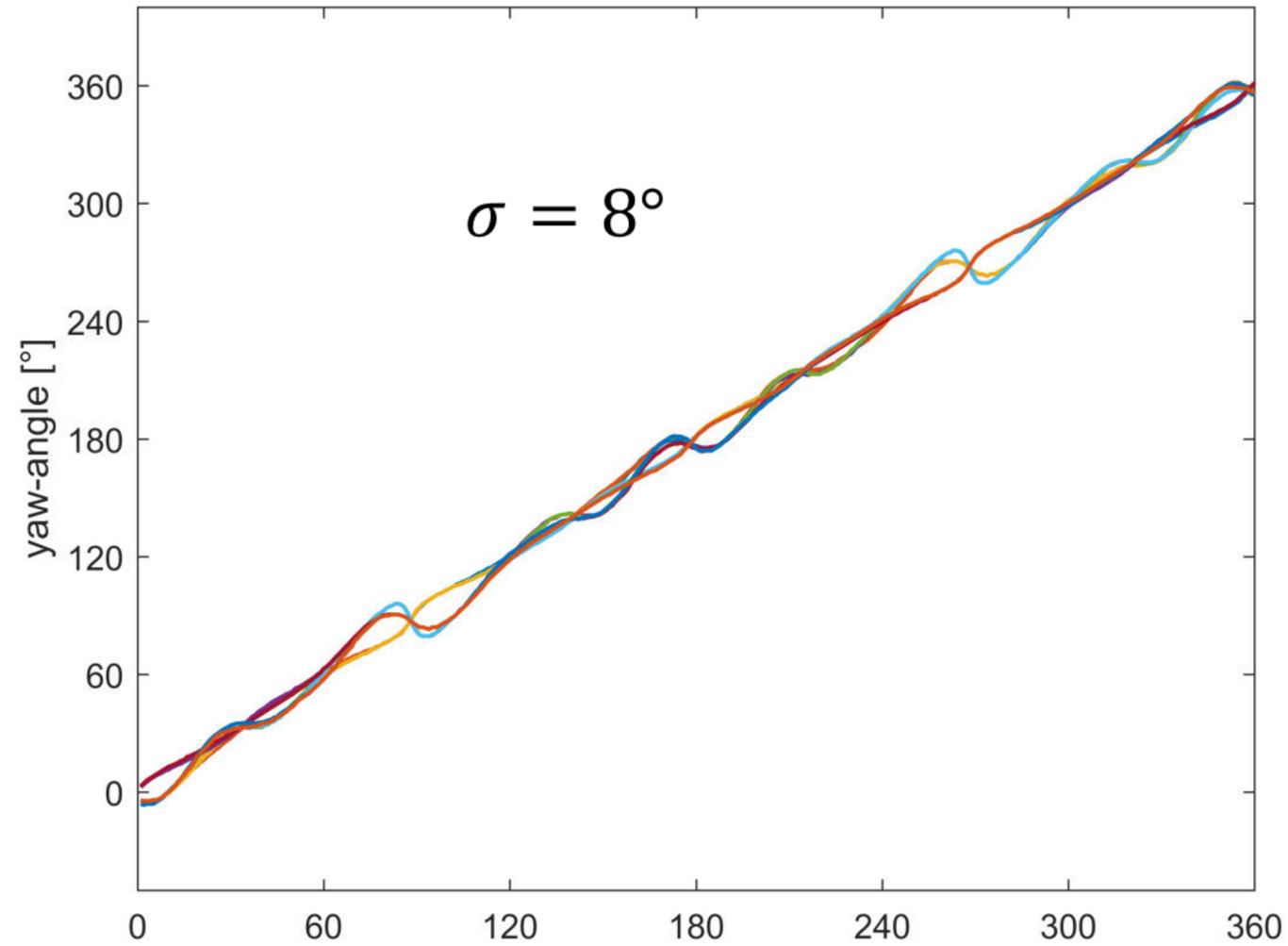
find

$$\arg \max_{\gamma_i} \int_0^{2\pi} \rho(\mu) \sum_{i=1}^n P_i((\gamma_j)_j, \mu) d\mu$$

for a probability distribution $\rho(\mu)$

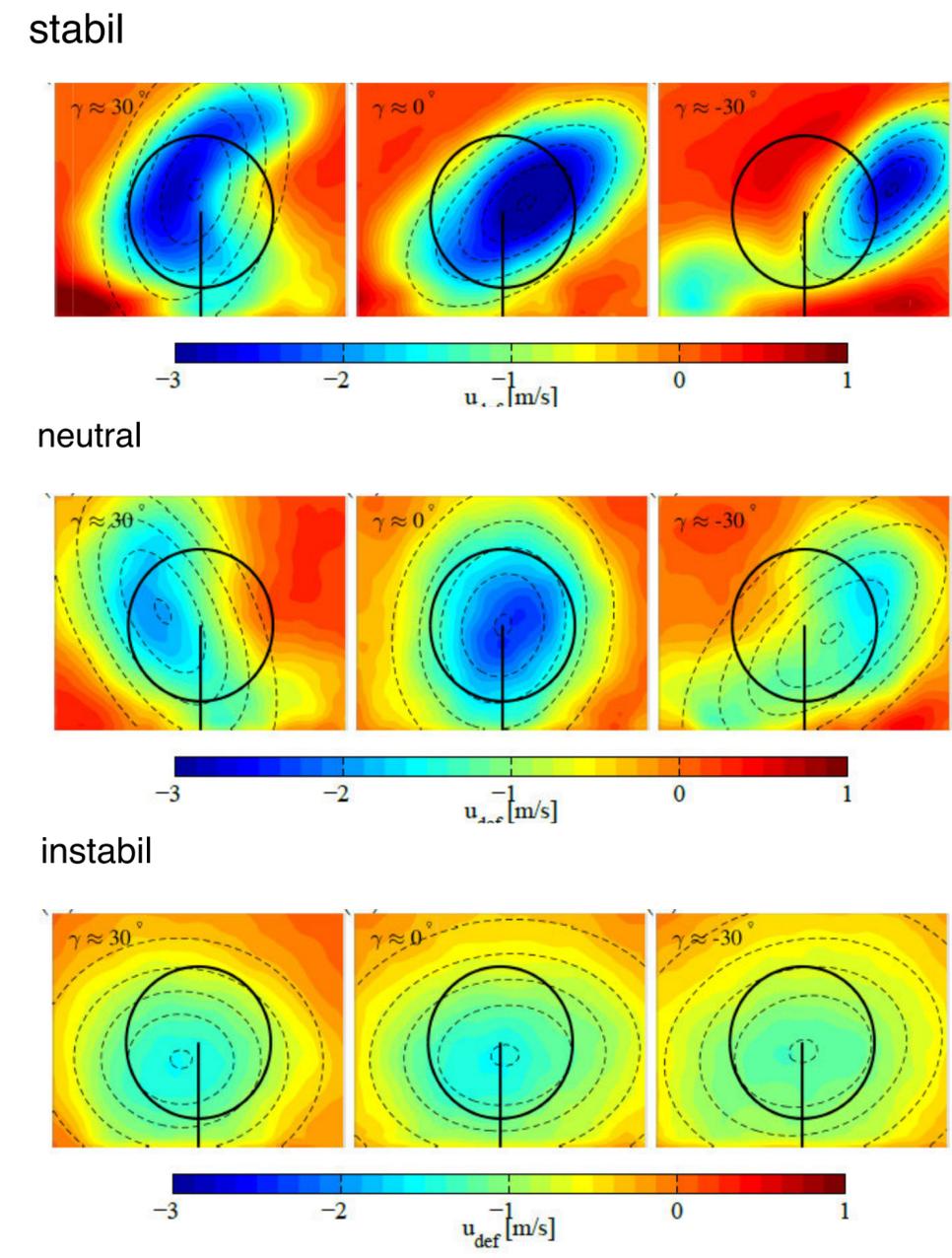
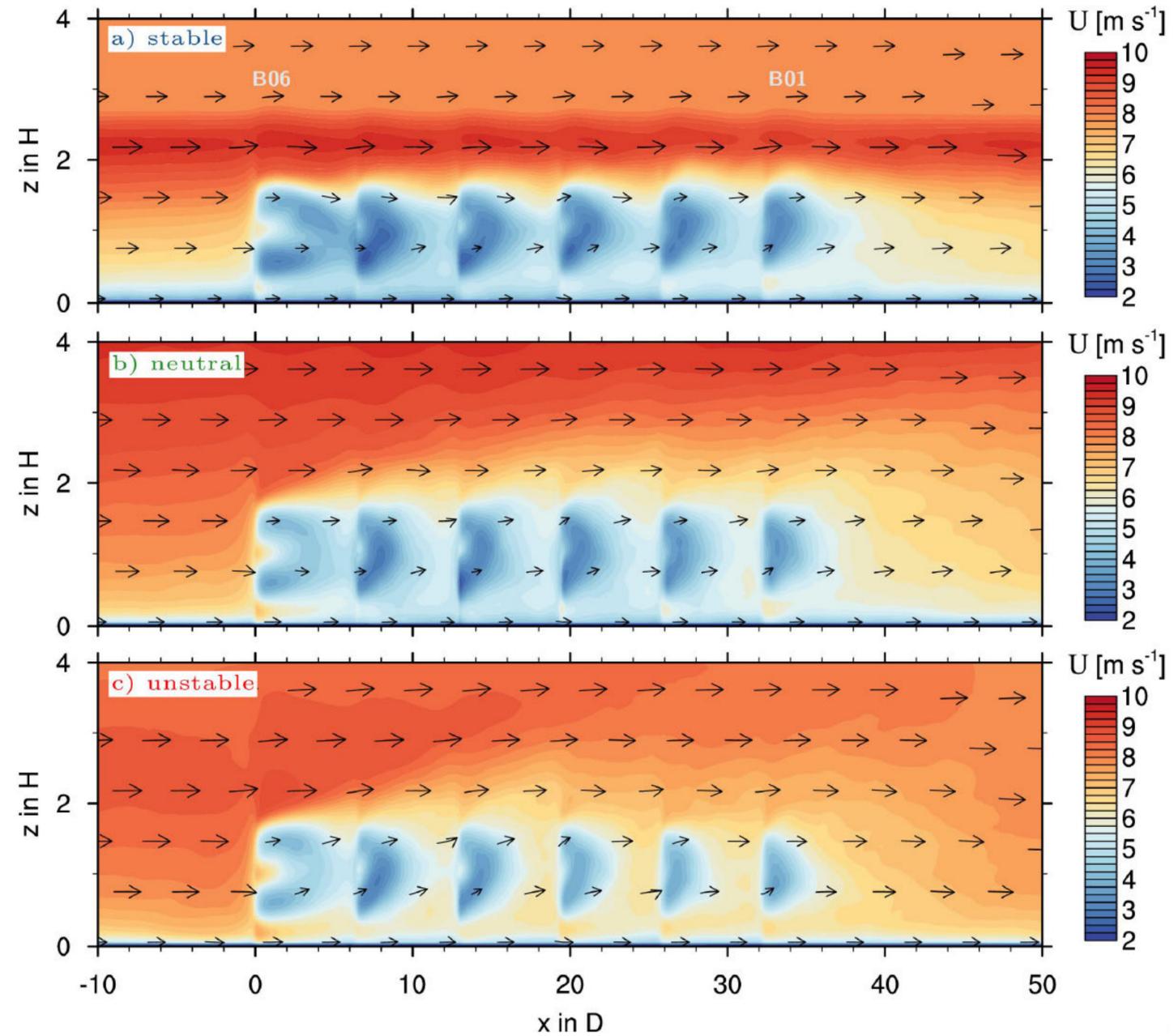


Anwendung auf einen 3 x 3 Windpark



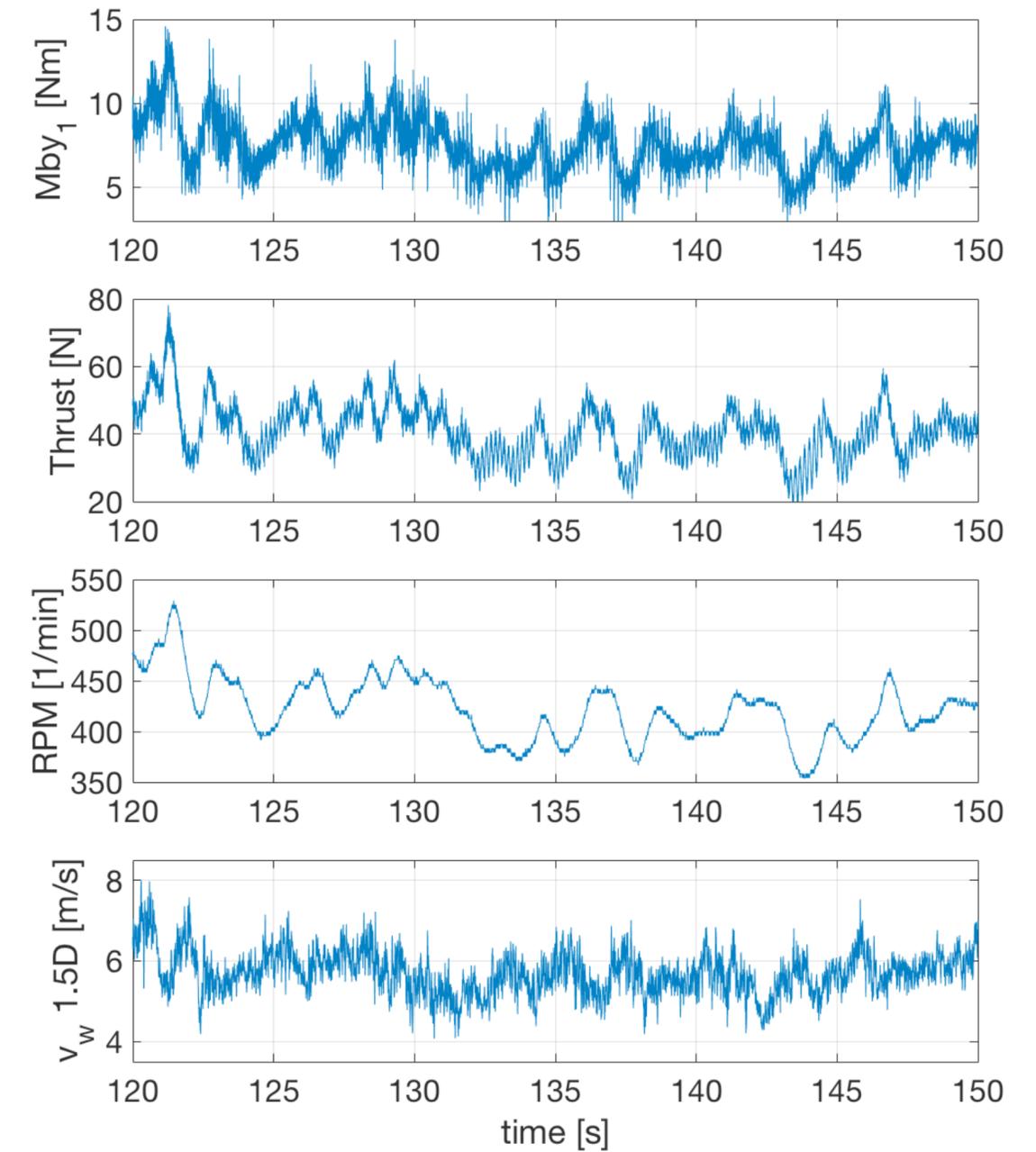
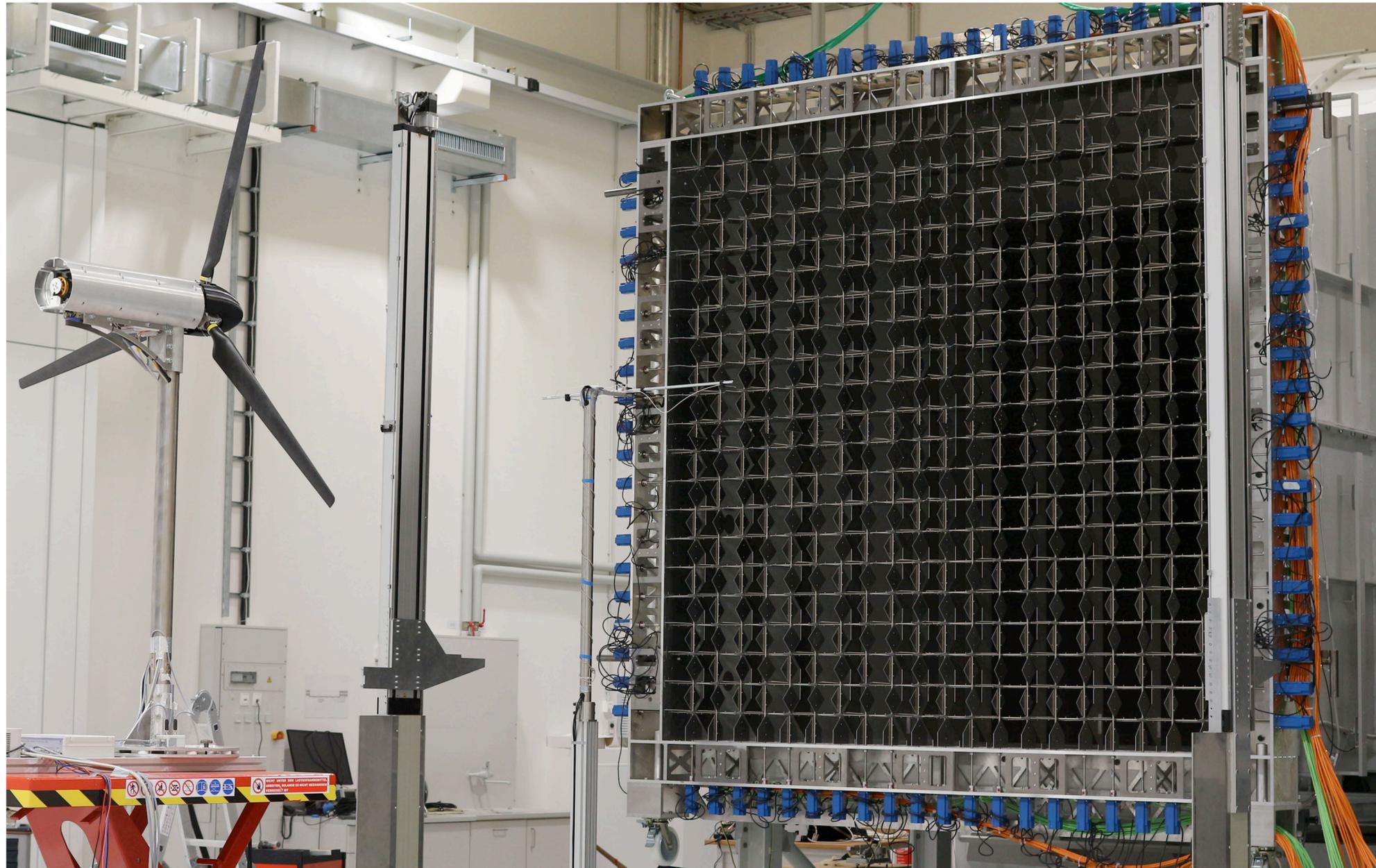
$$\emptyset \left(\frac{P_{\text{opt}}}{P_{\text{con}}} - 1 \right) = 1.03 \%$$

Aber: Die Schichtung der unteren Atmosphäre hat einen erheblichen Einfluss

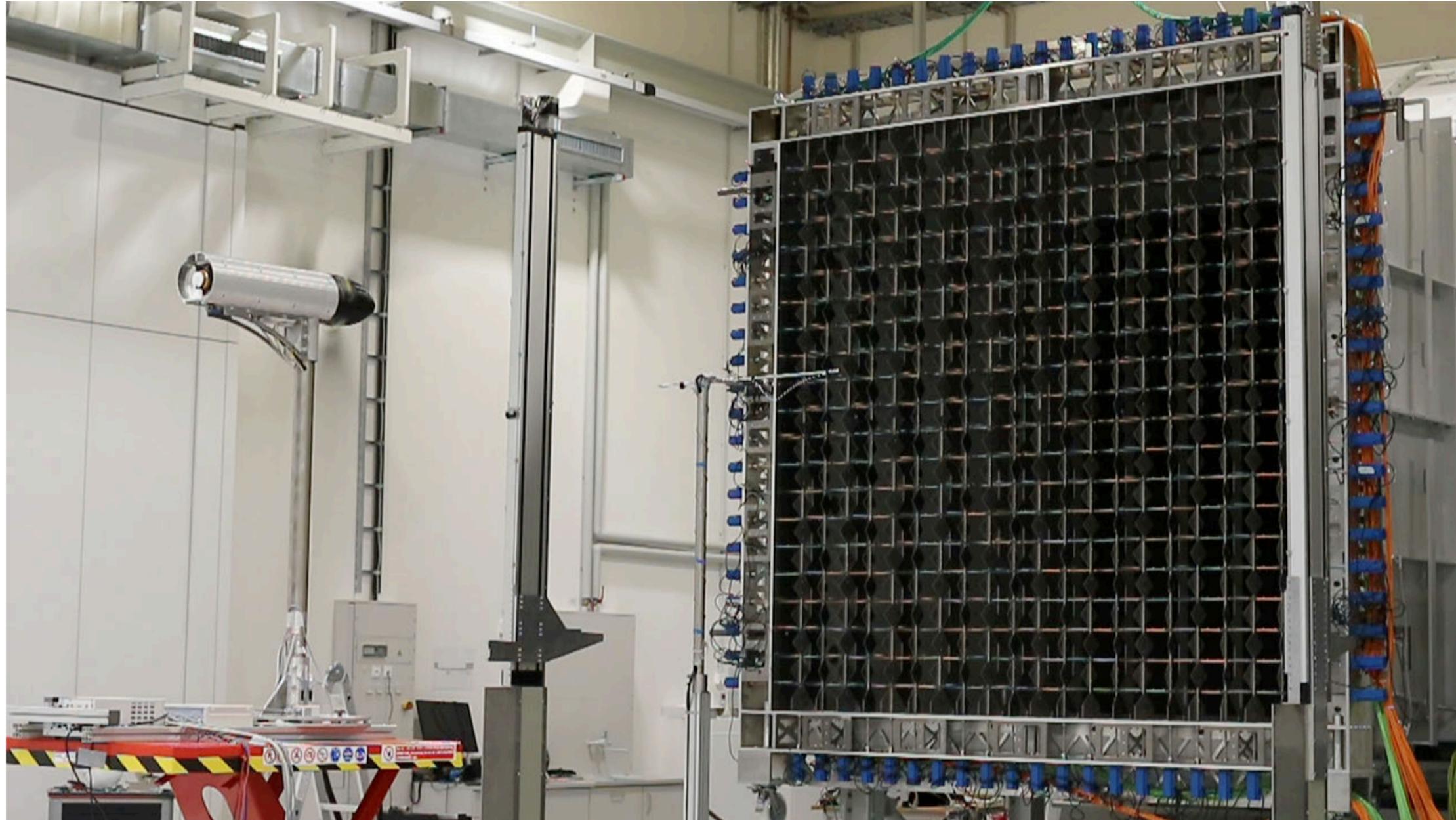


www.wind-energ-sci.net/1/129/2016/

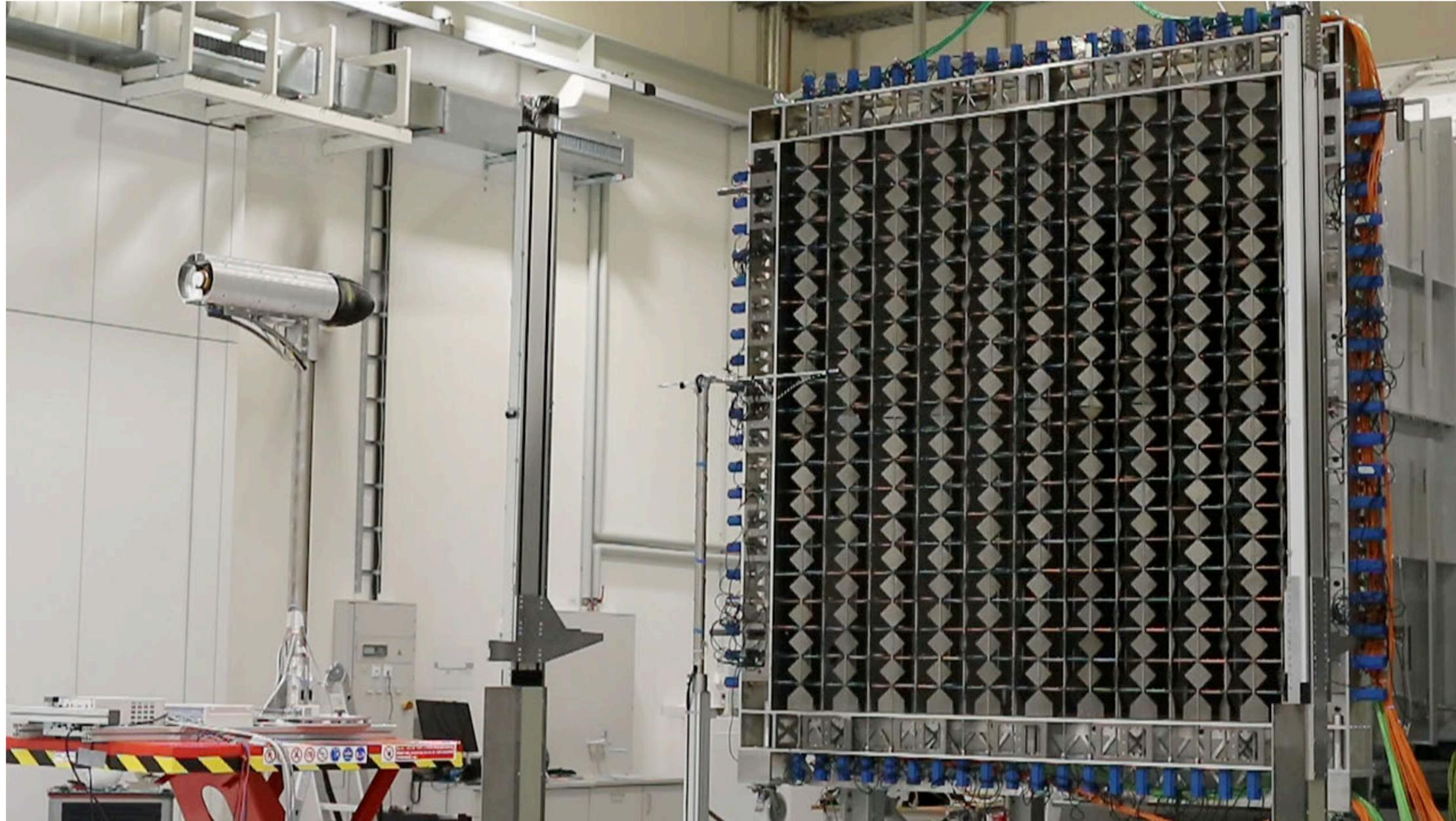
Experimentelle Untersuchungen im Windkanal



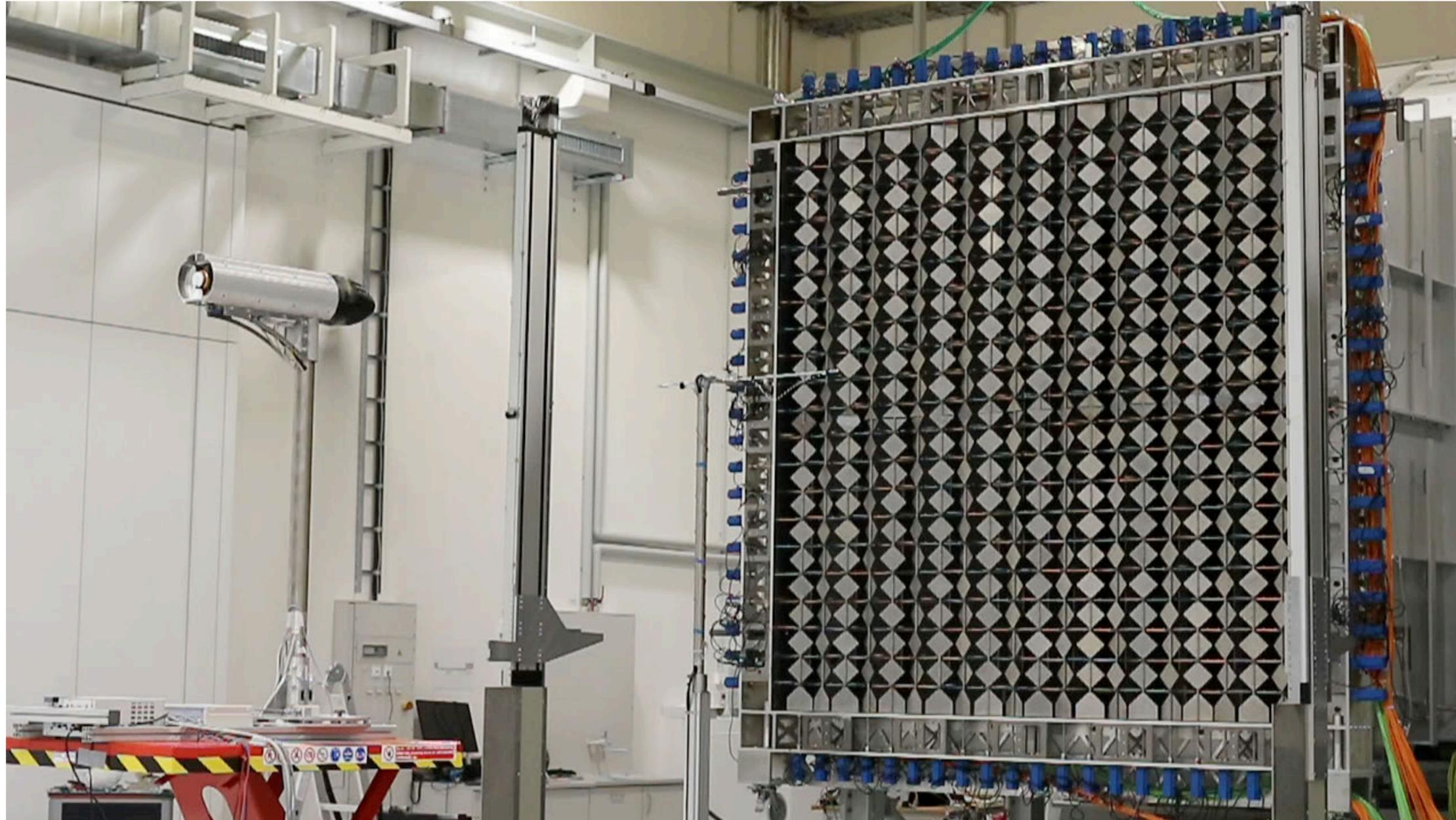
Aktives Gitter z. B. zur schnellen Windrichtungsänderung



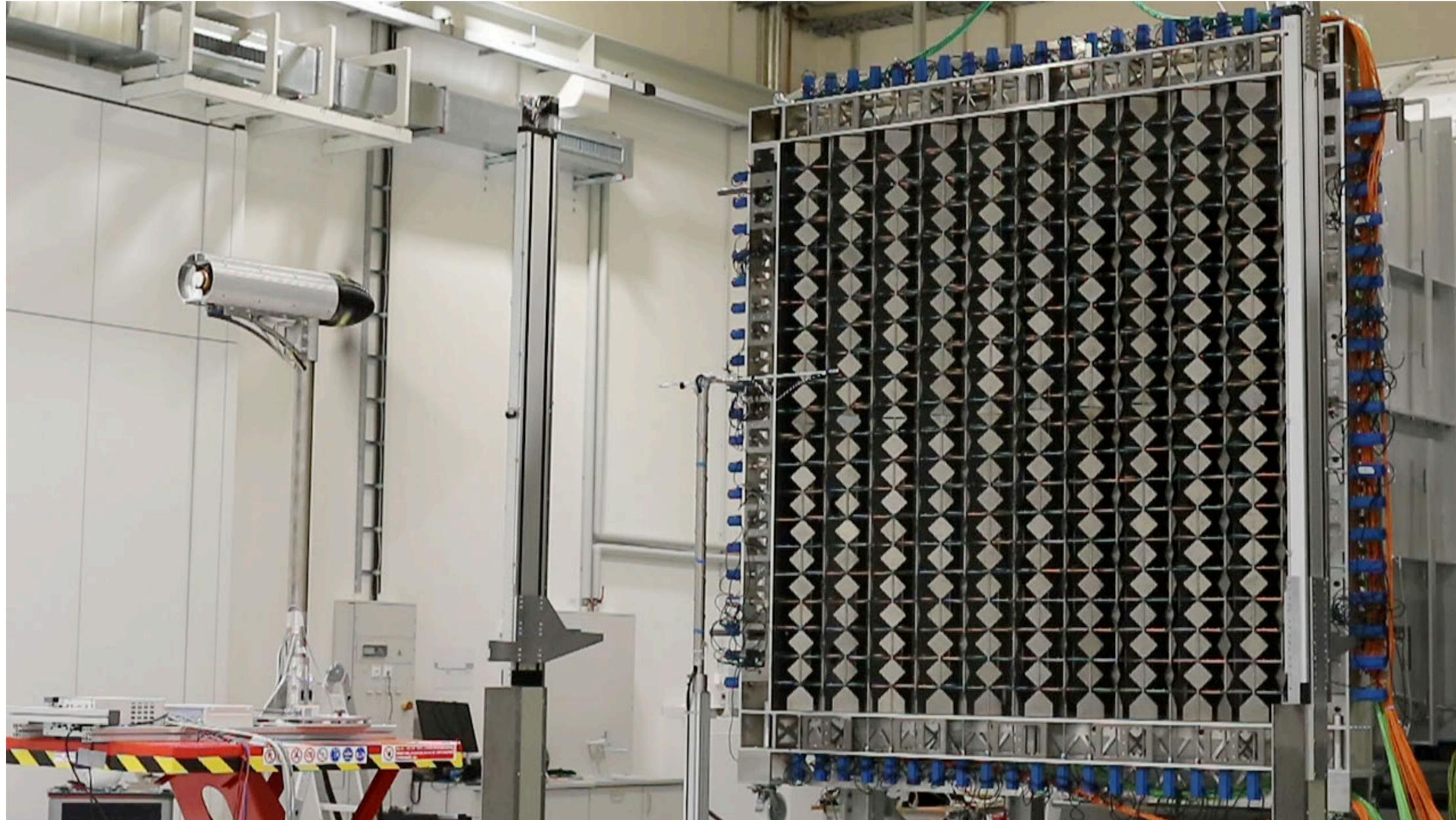
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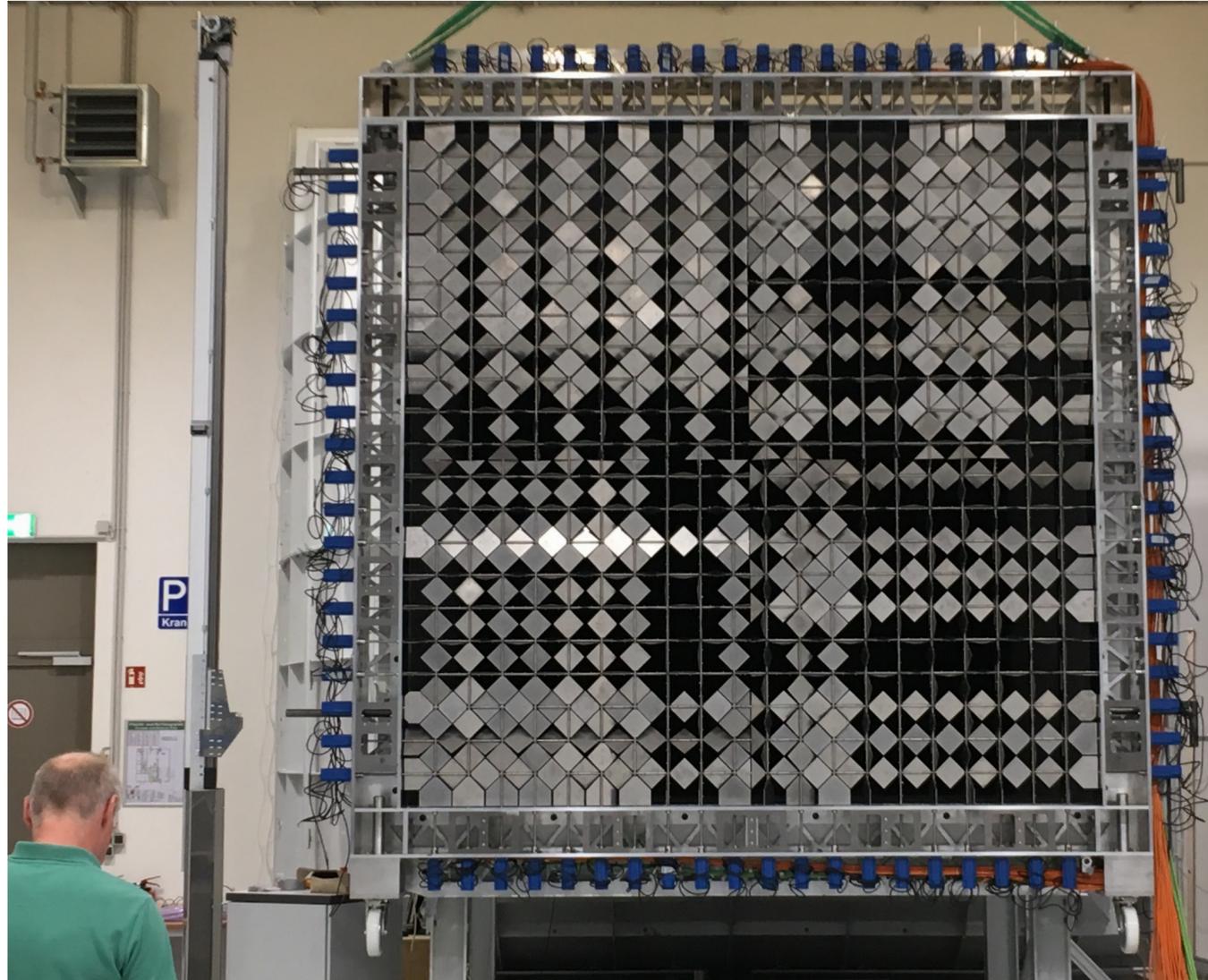
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Aktives Gitter z. B. zur schnellen Windrichtungsänderung



Große Flexibilität in der Strömungskonfiguration



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aufgrund eines Beschlusses
des Deutschen Bundestages

