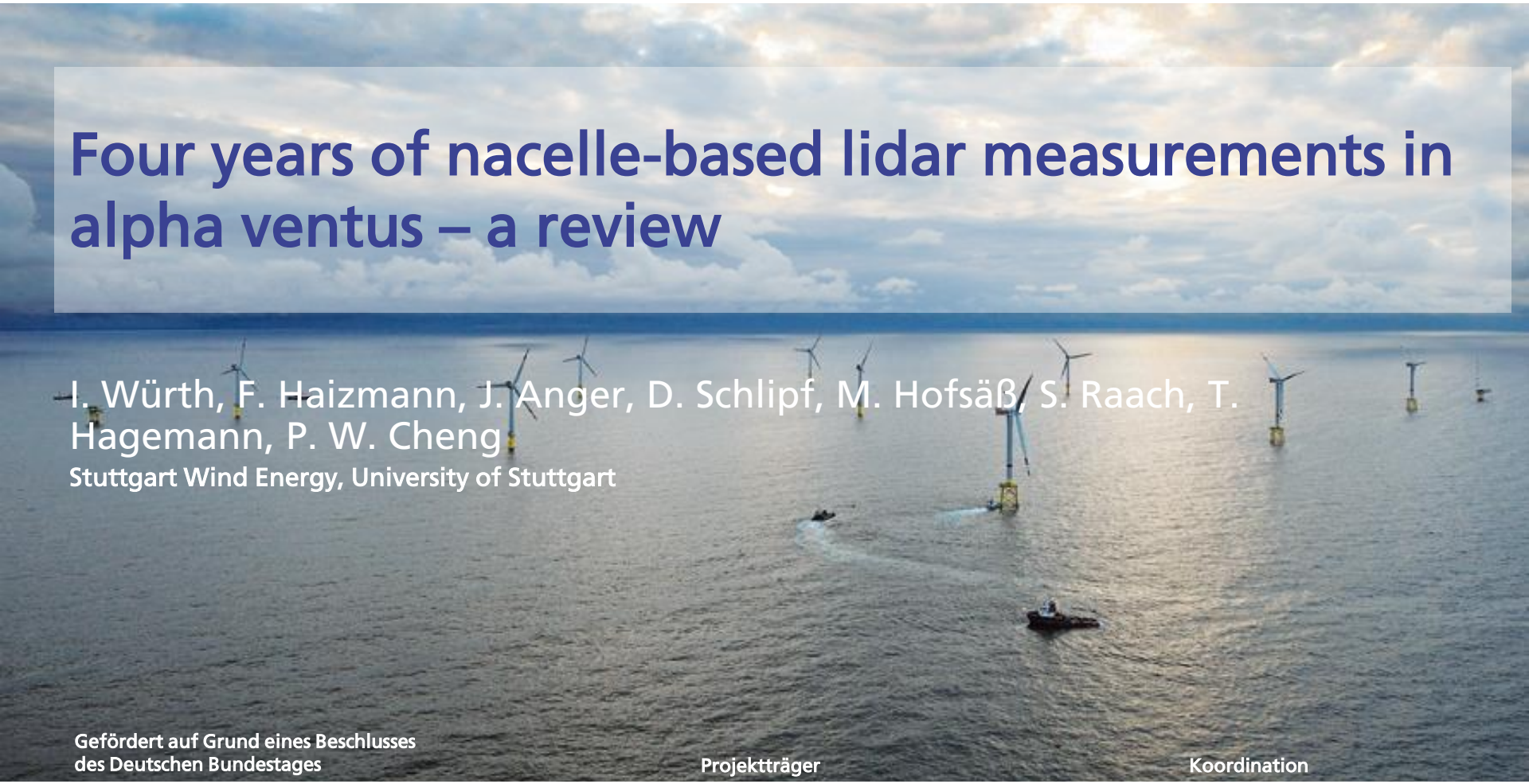

Four years of nacelle-based lidar measurements in alpha ventus – a review

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Stuttgart Wind Energy, University of Stuttgart

Gefördert auf Grund eines Beschlusses des Deutschen Bundestages

Projektträger

Koordination

Motivation

AV7

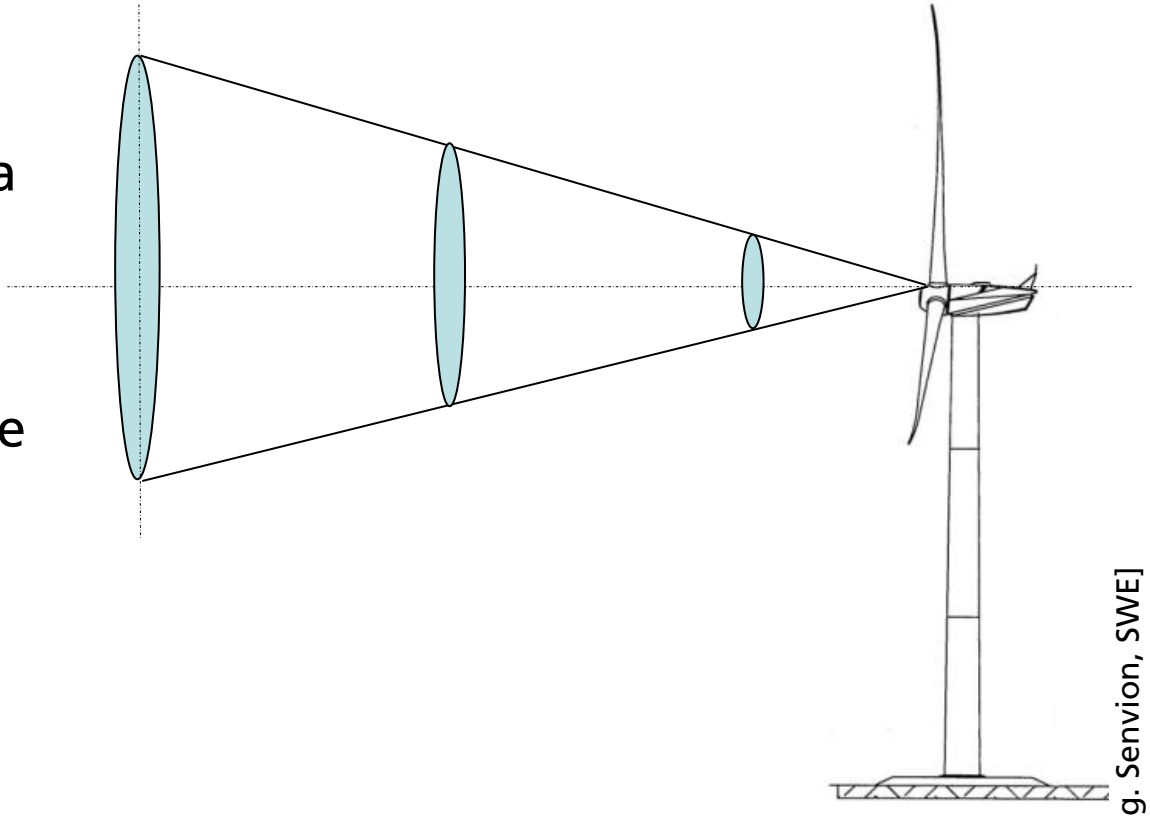
AV4

[Fig. DNV GL, SWE]

Motivation

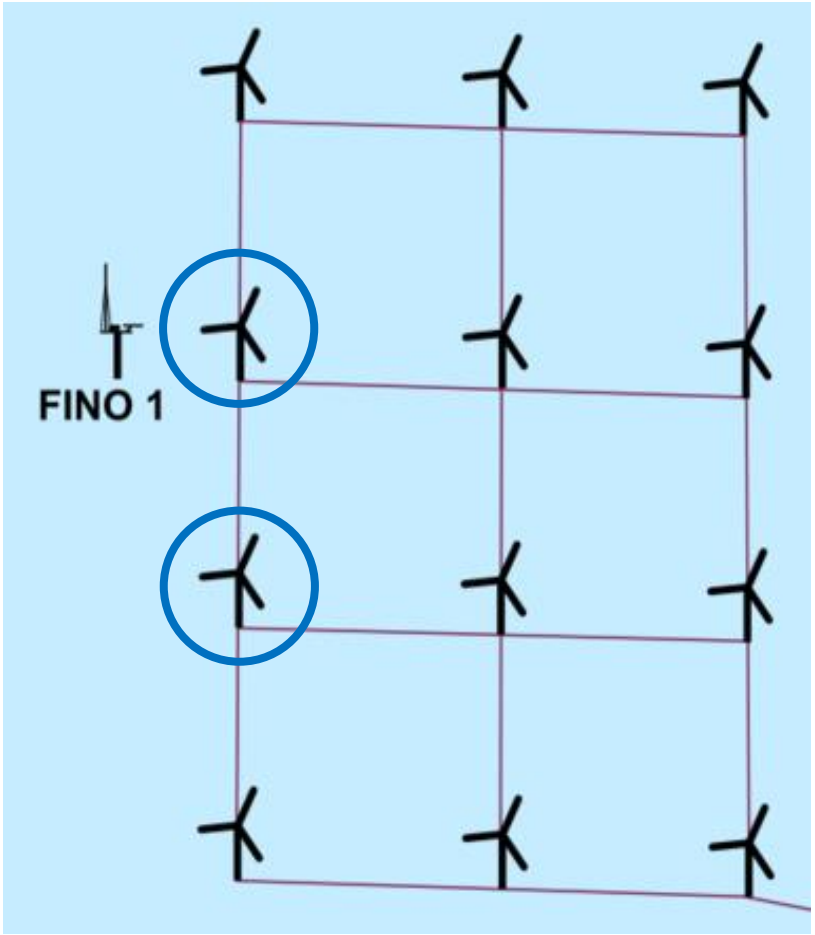
Nacelle based lidar measurements

- Wind field measurement over the whole swept rotor area
- Different measurements: inflow, wake, flow through the turbine
- Different applications possible (power curve, control, wake)



[Fig. Senvion, SWE]

Measurement Setup



[Fig. DNV GL, SWE]

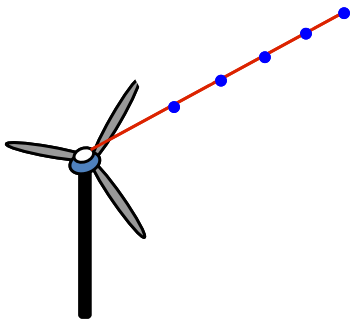
SWE Lidar System

- Laser beam is diverted by a 2DOF mirror
- Arbitrary trajectories
- Very fast scanning of measurement points up to 6Hz

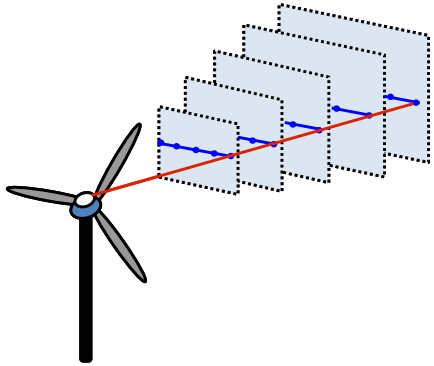
[Fig. SWE]

Where to measure - main trajectories

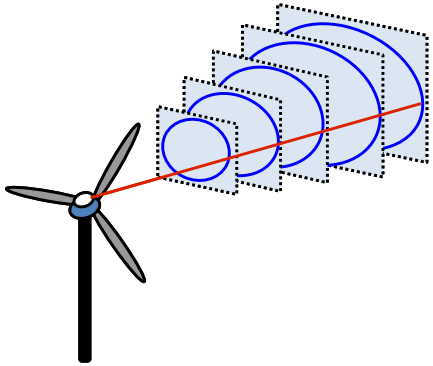
Staring mode (1D)



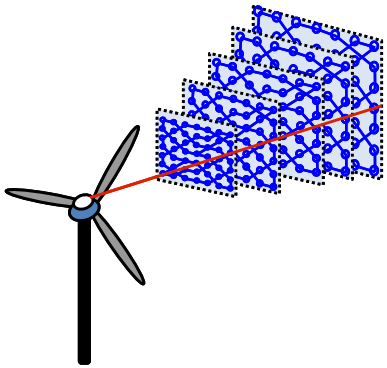
Sliding mode (2D)

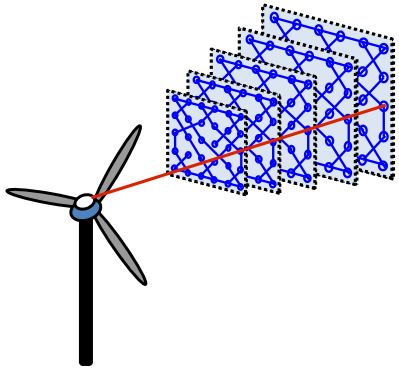


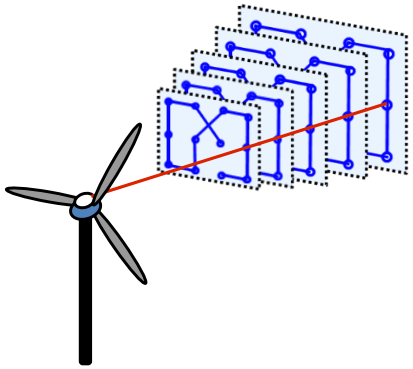
Circle (3D)



Liss2Grid (3D)



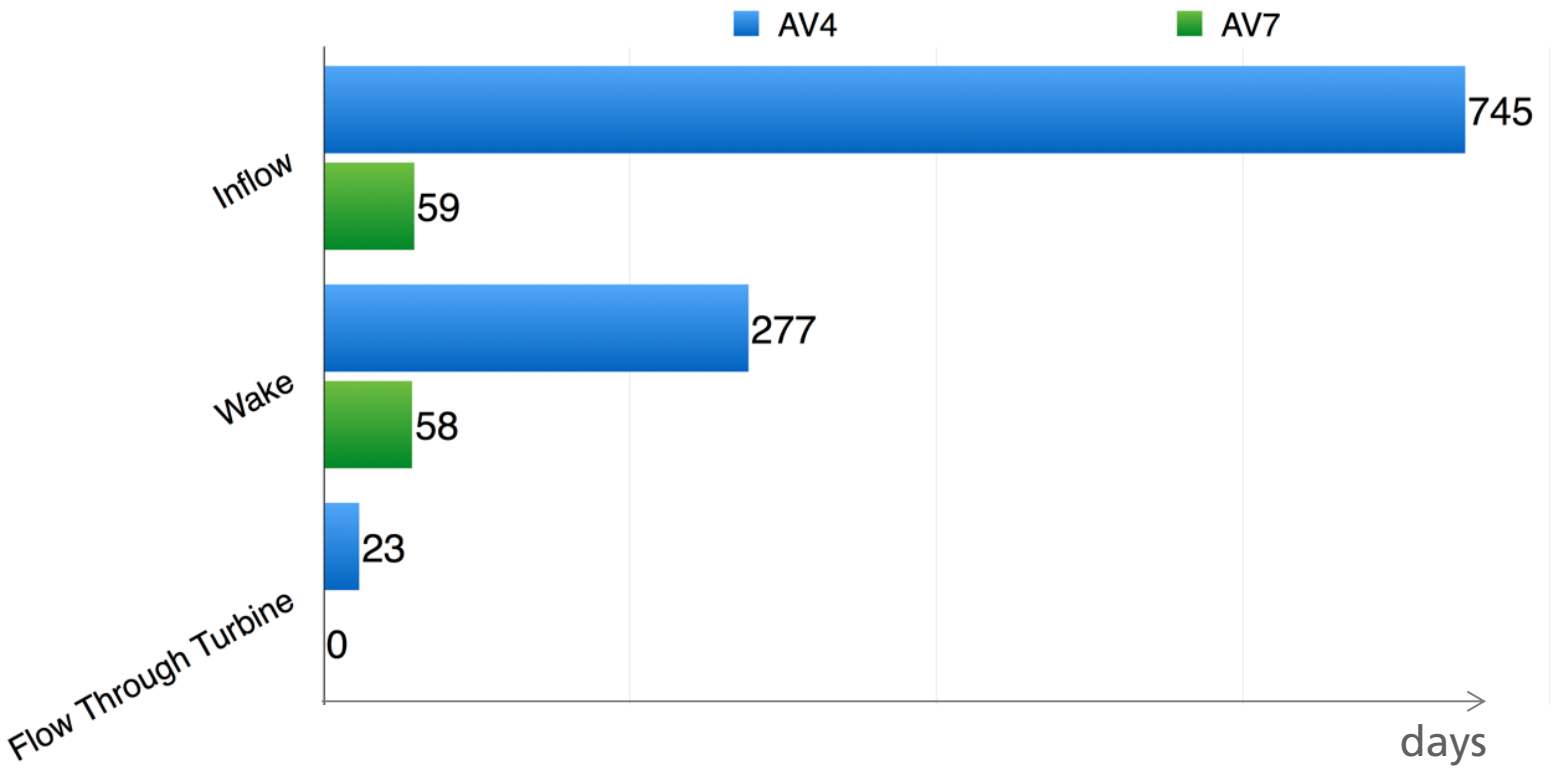




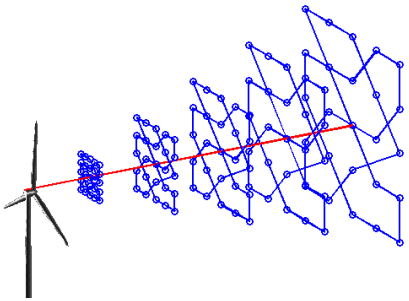
[Fig. SWE]

Overview of measurements

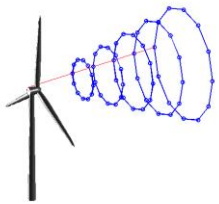
- In total 1162 days of measurements



Overview of measurements

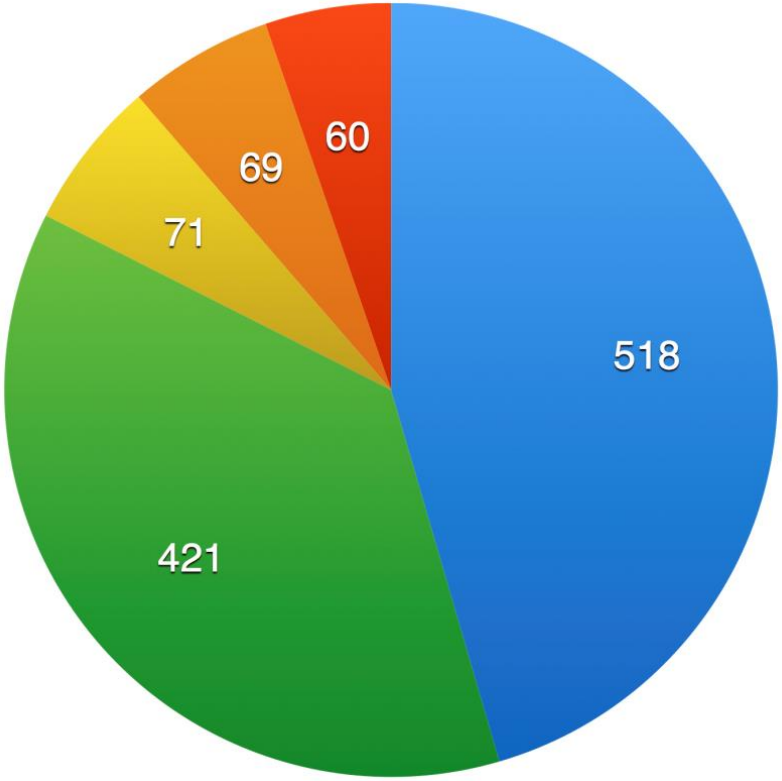


Liss2Grid 5x5

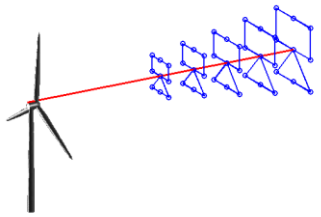


Circle

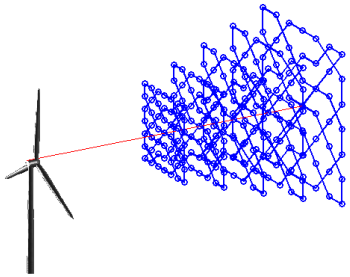
Others



days

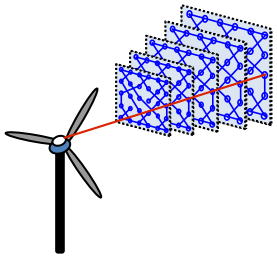


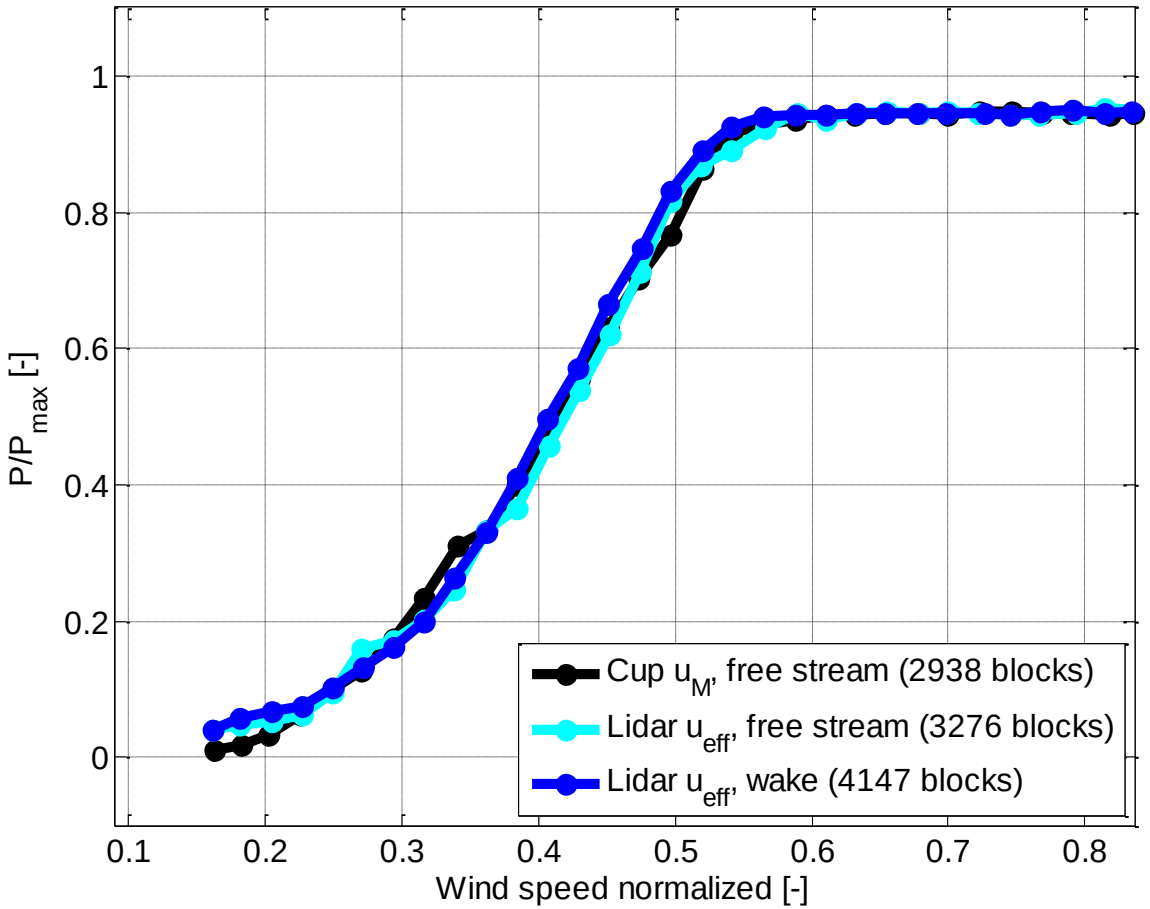
Liss2Grid 3x3 Tree



Liss2Grid 7x7

Trajectory optimization: power curves





$$u3\_A = \sqrt[3]{\frac{1}{A}\Sigma}$$

$$\frac{1}{5}\sum_{i=1}^{5}\overline{u_i}$$

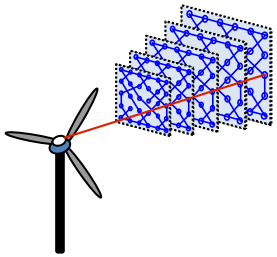
A : rotor s

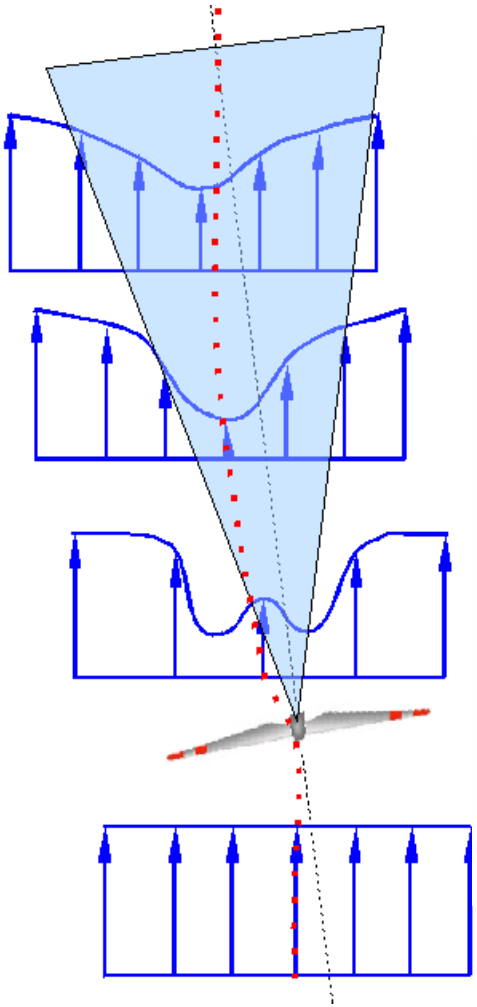
$\overline{u_i}$: averag

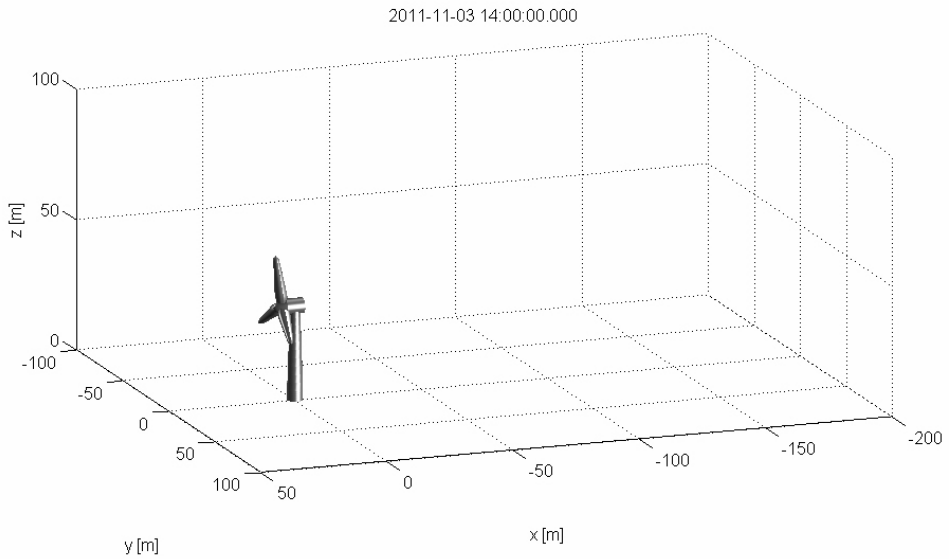
A_i : area of

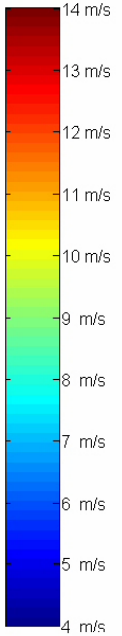
[Fig. SWE]

Trajectory optimization: wake









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[Fig. SWE]

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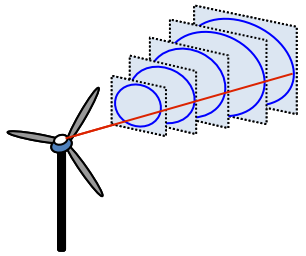
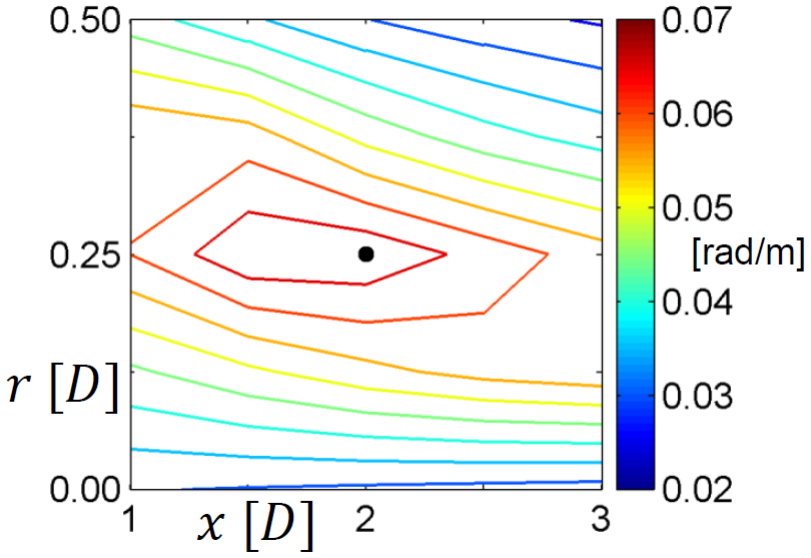
RESEARCH AT ALPHA VENTUS
Eine Forschungsinitiative des Bundesumweltministeriums

Trajectory optimization: control



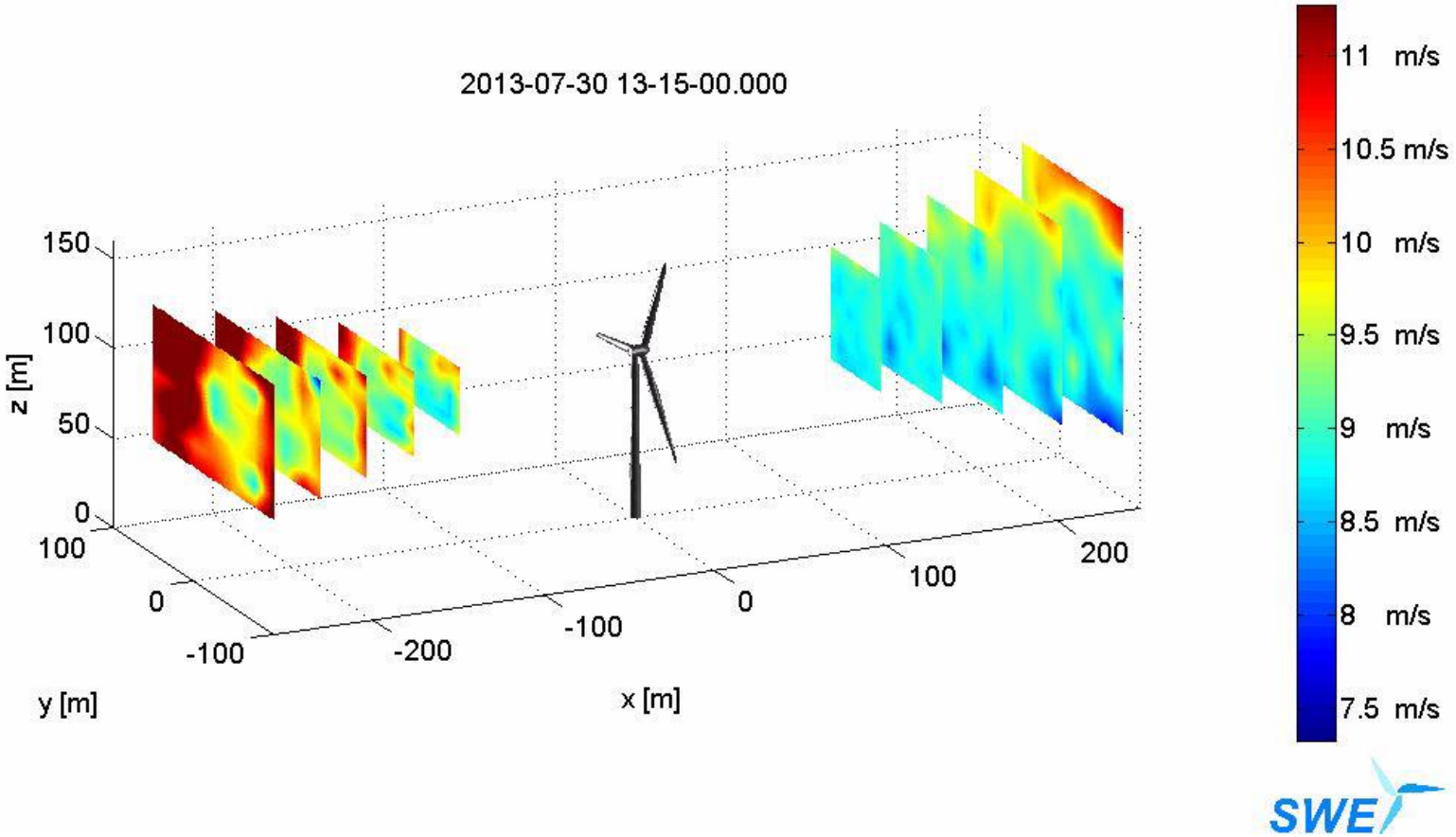


customized trajectory with model [Schlipf, ISARS2012]

- best correlation:
  - circle 6 points
  - $r = 0.25D$
  - $x = 2D$

[Fig. SWE]

Trajectory optimization: flow through the turbine



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Practical lessons learned

- Very extreme and harsh environmental conditions
  → humidity leakage is an issue
- Constant monitoring of lidar is necessary
  → good remote access, webcam
- Maintenance is a challenge, difficult access
  → can lead to low data availability

→ need for robust lidar!

Storm front Katrin 10/2014

Summary

- 1163 days of lidar data available
- Mostly inflow and wake measurements
- Different trajectories for different applications
- Lessons learned: need for a robust lidar!

How to get the data?

- Data is uploaded in the RAVE database
- Documentation is available

Thank you for your interest!

Acknowledgements
The RAVE-Lidar II project (FKZ 0325216) is funded by the Federal Ministry for Economic Affairs and Energy

[Fig. SWE]