

# Selected research results from alpha ventus wind farm (RAVE) and beyond

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Funding Body

Supervisor

Coordination

# Outline

1. In a nutshell
  - alpha ventus
  - RAVE
2. Selected Results
  - Detecting scour / BSH
  - Sensing wakes / Forwind
3. Beyond RAVE
4. Conclusions

## Acknowledgements:

Bettina Kühn



Jörg Schneemann

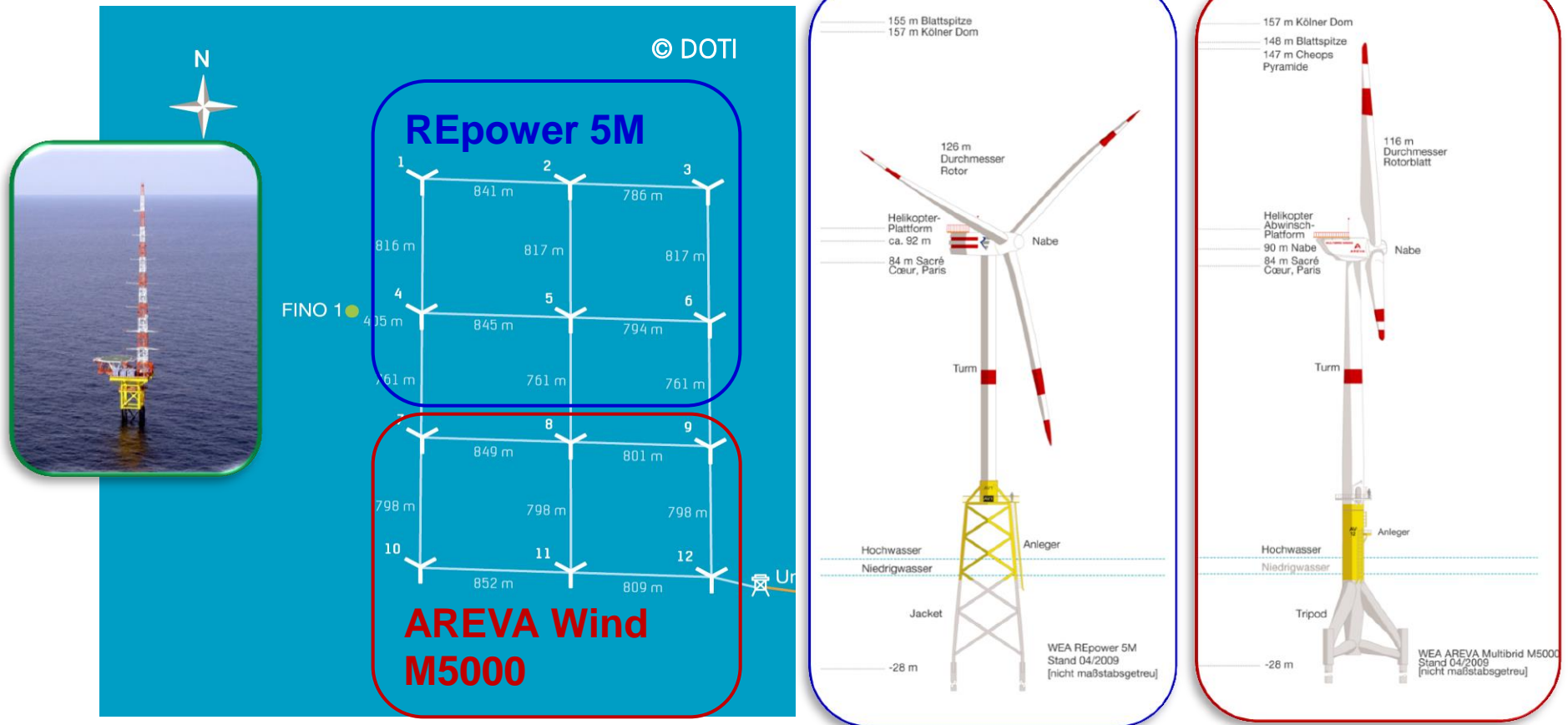


# alpha ventus: project details

- North Sea, EEZ
- 45 km north of Borkum
- Water depth: 30 m
- 12 turbines 5 MW class  
AREVA Wind M5000  
REpower 5M
- CAPEX: 250 M€
- AEP: 267 GWh  
(2011, 2012)



# Layout of alpha ventus





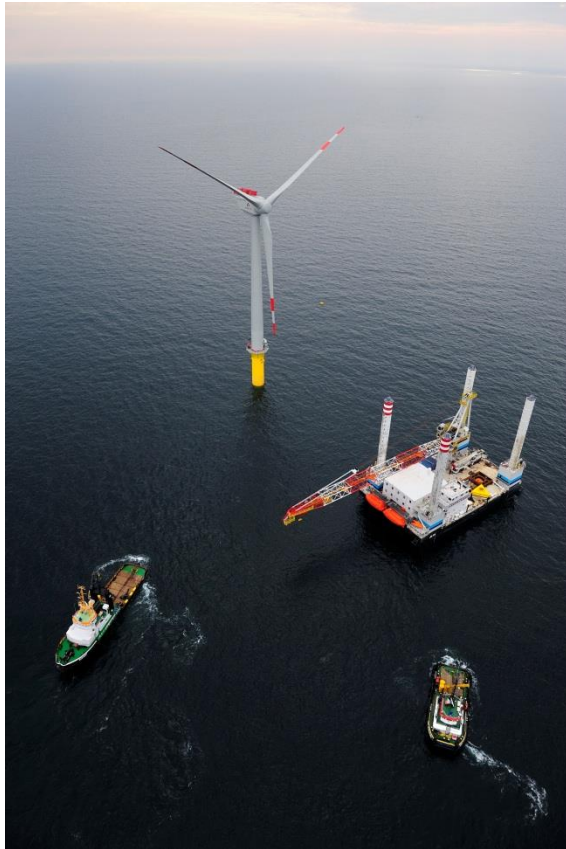
# RAVE – Research at alpha ventus

- Funded by the German Federal Environment Ministry (BMU)
- Accompanying research at the alpha ventus test site
- +30 R&D projects
- +50 mill. € support
- +50 project partners
- RAVE – Steering Committee :

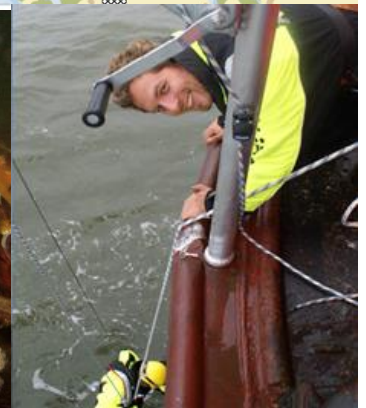


# Main objectives of RAVE

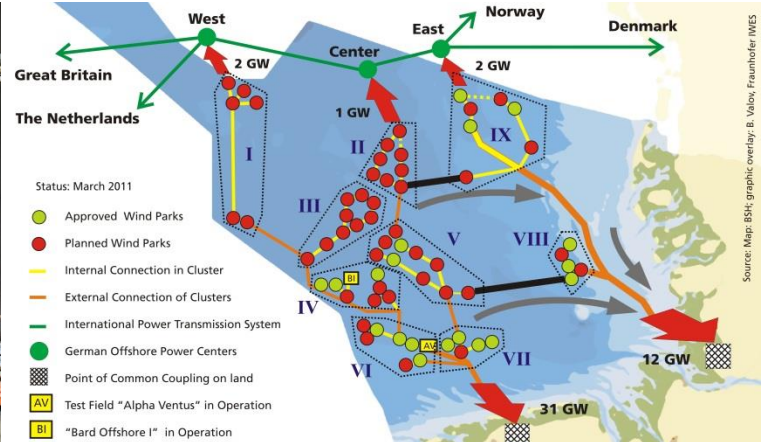
## Demonstration



## Development



## Investigation of OWP issues



## Expand research, experience & expertise

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Research at alpha ventus – Bernhard Lange  
25.9.2014 IRPWind conference, Amsterdam



# RAVE Research Projects

Technology-Monitoring and O&M

Meteorology

Grid integration

LIDAR

Turbine Design

REpower Blades

AREVA Wind  
M5000 Improvement

Offshore conditions

REpower Components

Foundations

Acceptance

Support structures

Sonar Transponder

Hydro Sound

Operational noise

Ecology

Geology / Oceanography

# RAVE – measurements

~ 1,200 sensors

■ strain gauges

■ acceleration

■ acoustic sensors

■ hydrographic sensors

■ met data (sonic, lidar)

■ sonars

■ water pressure sensors

■ SCADA

■ corrosion

👁 video cam, radar





# Selected results (1)



BUNDESAMT FÜR  
SEESCHIFFFAHRT  
UND  
HYDROGRAPHIE

## Geological research at *alpha ventus* *The spatiotemporal development of scours*

Bettina Kühn

Federal Maritime and Hydrographic Agency  
Berlin, 30. Oktober 2013

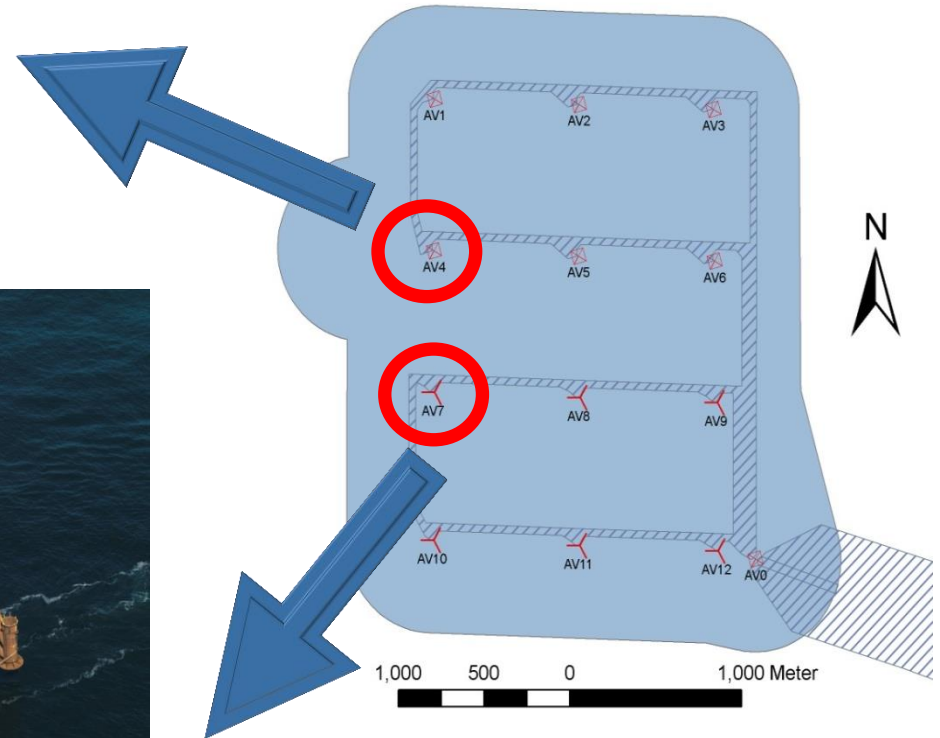
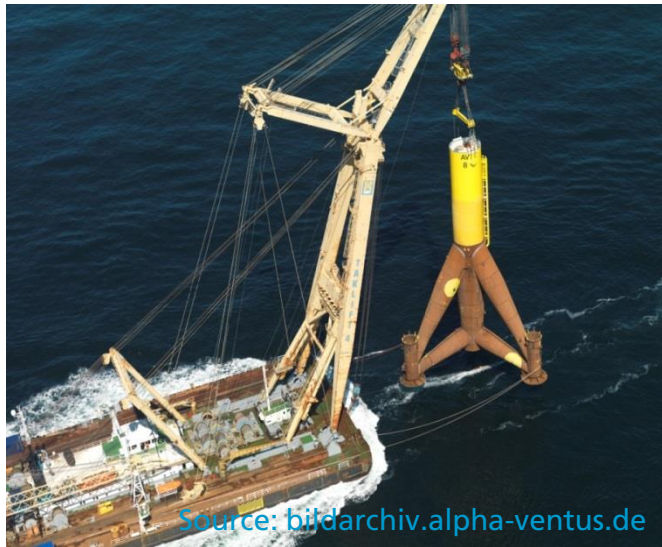
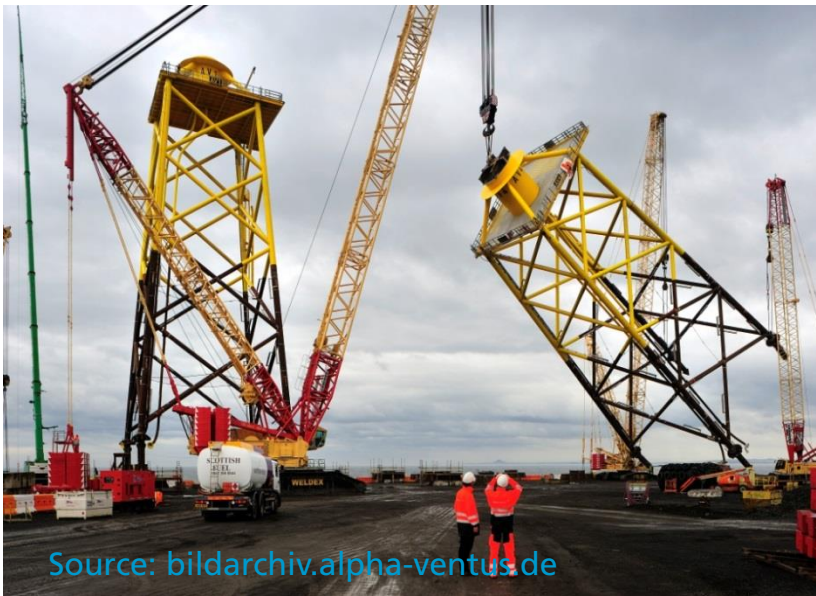


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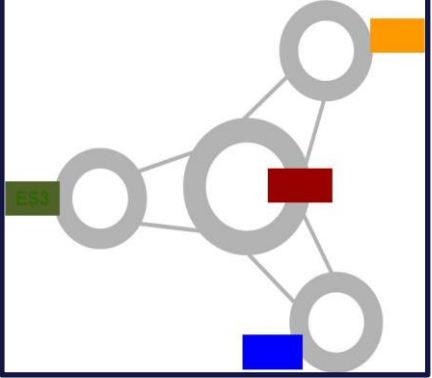


# The *alpha ventus* test site

Source: BSH, B. Kühn

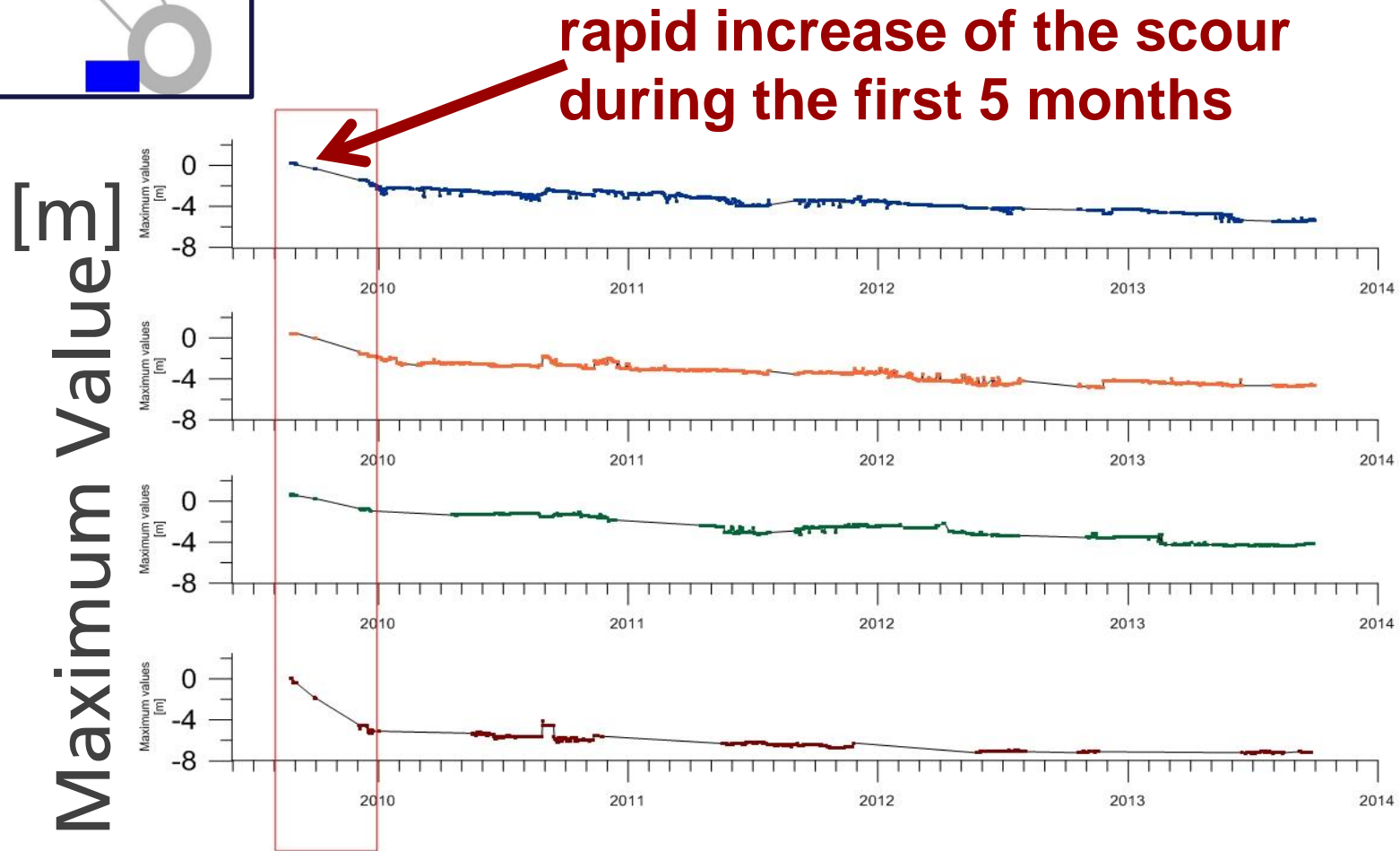


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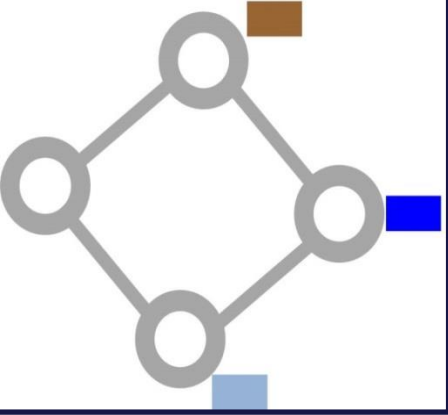


# Development of scour depth in time

Source: BSH, B. Kühn





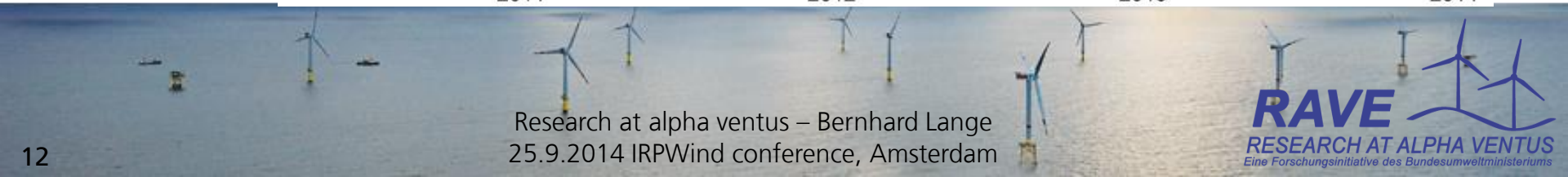
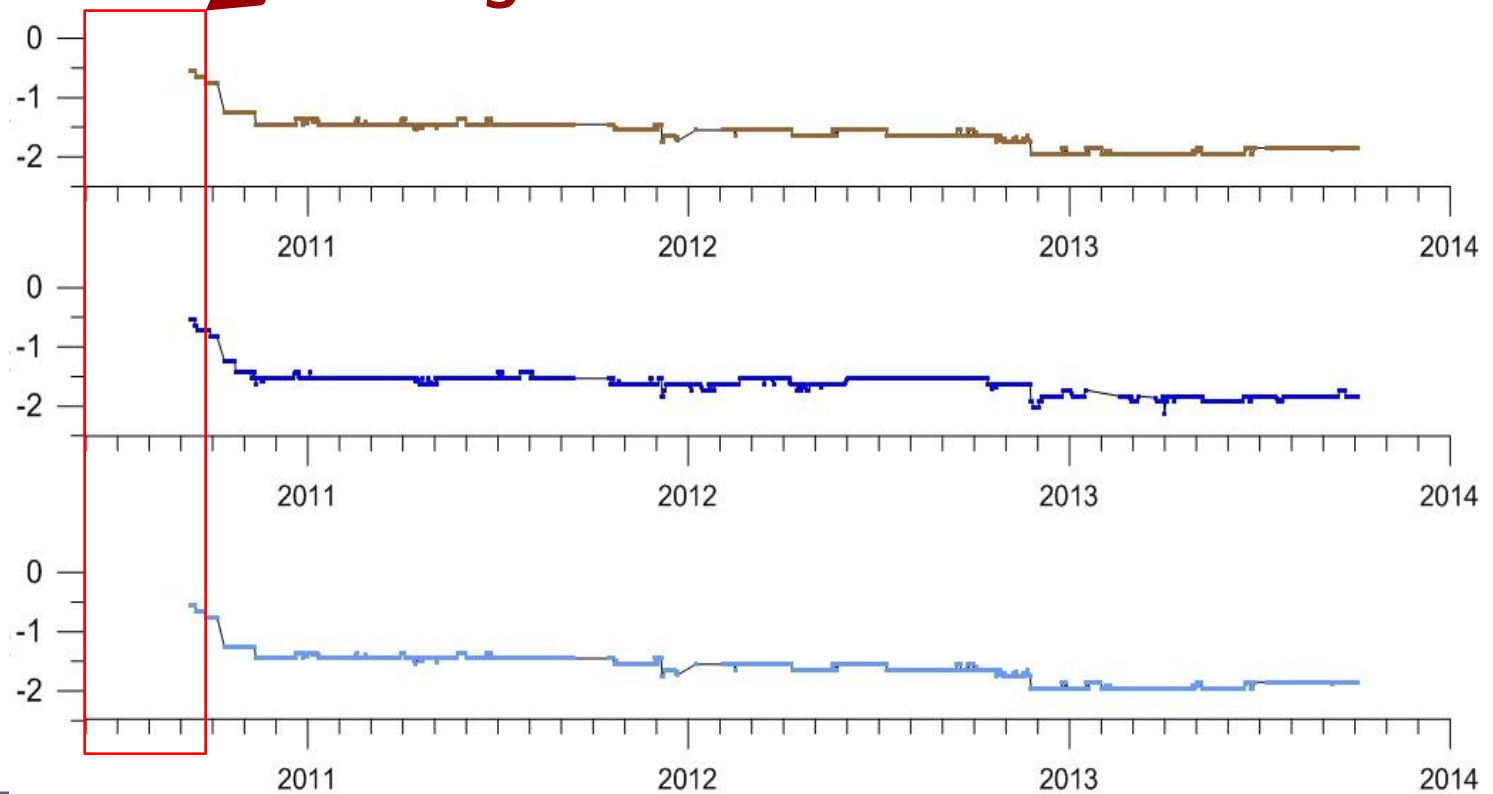


# Development of scour depth in time

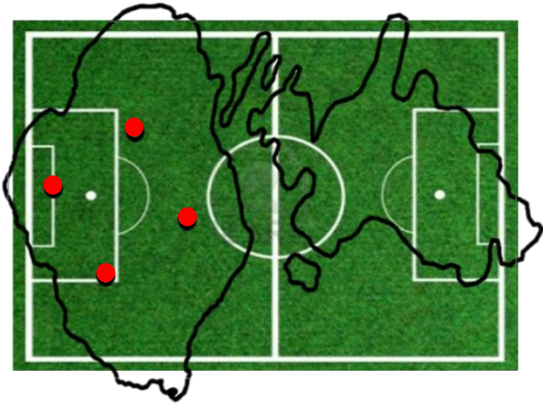
Source: BSH, B. Kühn

**rapid increase of the scour during the first 3 months**

**Maximum Value**  
[m]



# The geometry of the scour (AV4)



7140 m<sup>2</sup>  
FIFA  
standard



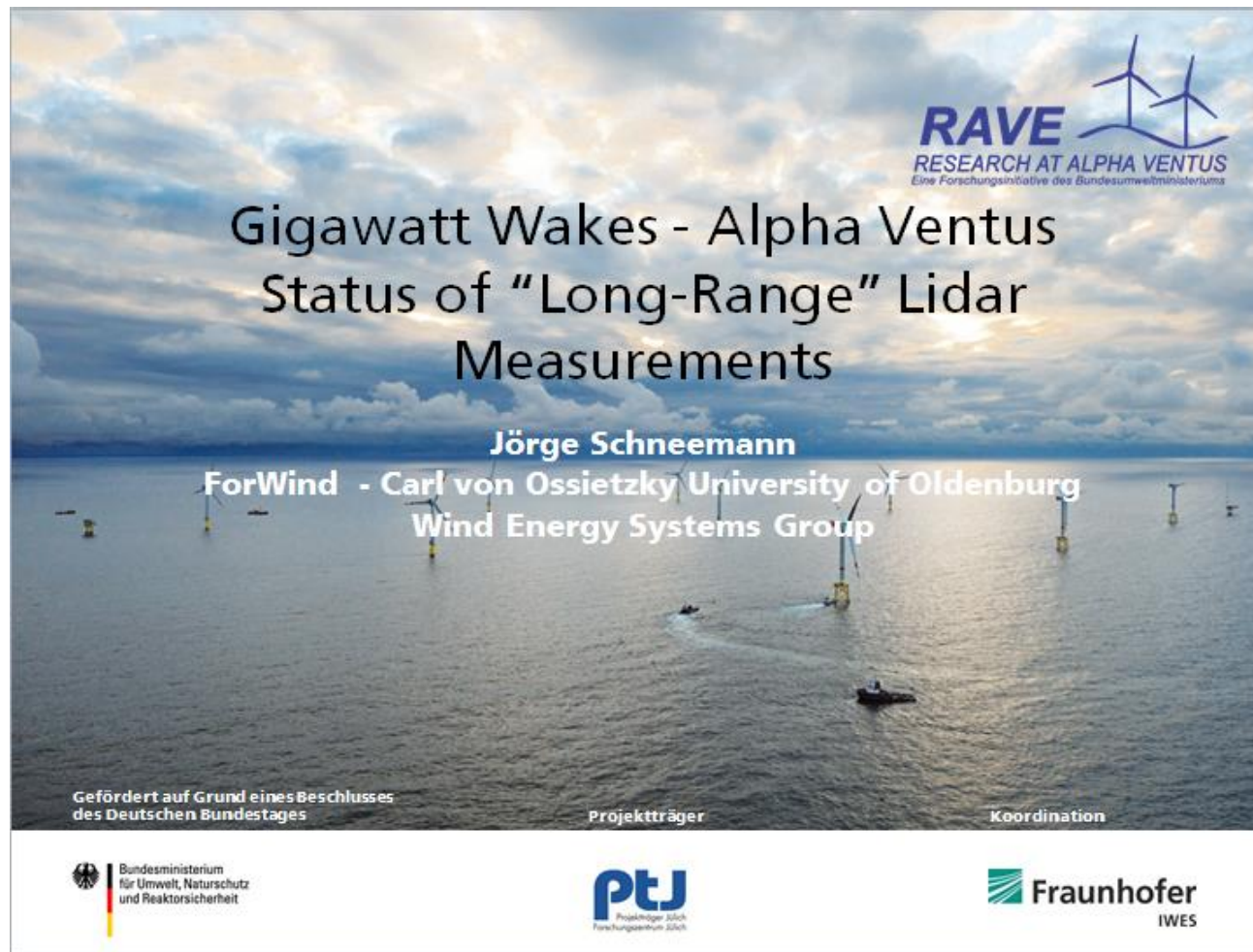
scour volume: 1700 m<sup>3</sup>  
scour area: 2400 m<sup>2</sup>

accumulation volume: 200 m<sup>3</sup>  
accumulation area: 1400 m<sup>2</sup>

Source: BSH, B. Kühn

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## Selected results (2)



**RAVE**  
RESEARCH AT ALPHA VENTUS  
Eine Forschungsinitiative des Bundesumweltministeriums


# Gigawatt Wakes - Alpha Ventus Status of "Long-Range" Lidar Measurements


**Jörg Schneemann**  
ForWind - Carl von Ossietzky University of Oldenburg  
Wind Energy Systems Group


Gefördert auf Grund eines Beschlusses  
des Deutschen Bundestages

Projektträger

Koordination

 Bundesministerium  
für Umwelt, Naturschutz  
und Reaktorsicherheit

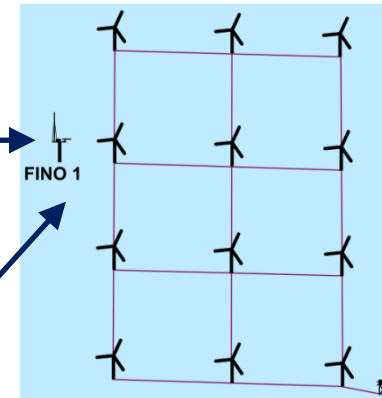
 PTJ  
Projektträger Jülich  
Forschungszentrum Jülich

 **Fraunhofer**  
IWES

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# Long range lidars in alpha ventus

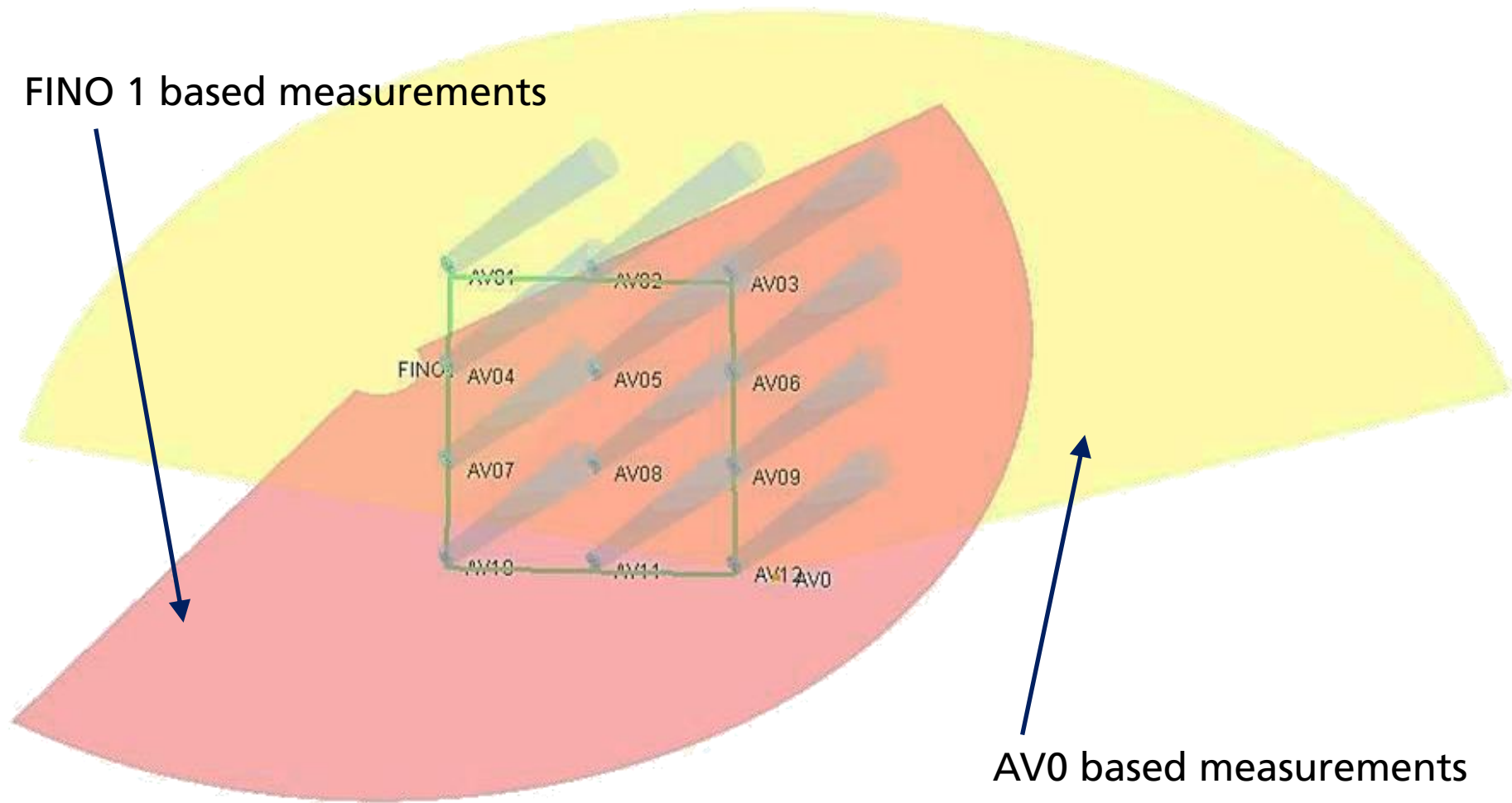


Location	Lidars
FINO 1	2 x WLS2005
Substation	1 x WLS2005

# Example of „long-range“ measurements

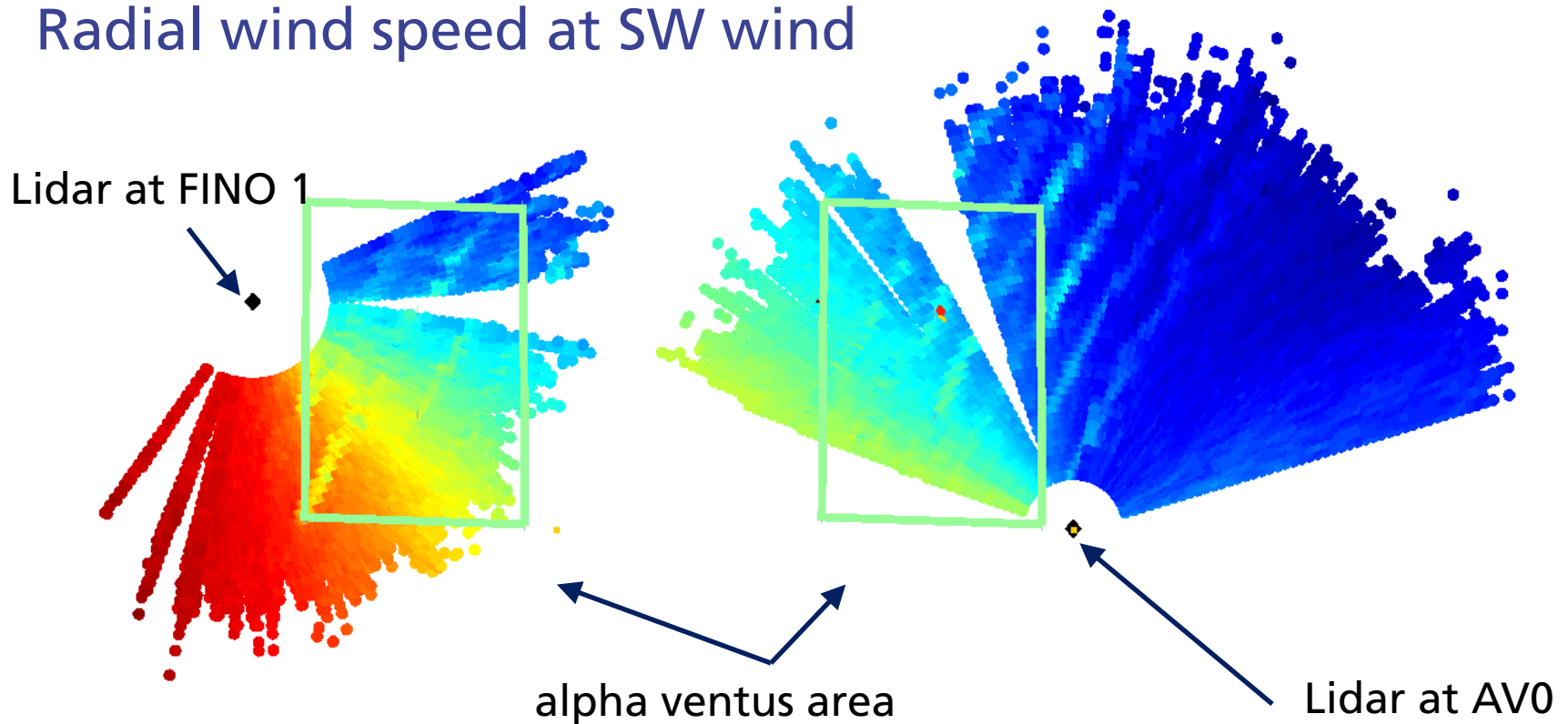
## Scan of azimuth at constant elevation

FINO 1 based measurements



# Example of „long-range“ measurements

## Radial wind speed at SW wind



ForWind – University of Oldenburg, Wind Energy Systems Group





# Next steps

- Coupling of data measured at FINO 1 and AV0  
⇒ “Dual Doppler Lidar”
- Synchronisation of two lidars on (quasi-) arbitrary 2D trajectories  
⇒ 2D cut of wind field  
⇒ Comparison to floating / ship lidar of FHG-IWES

Contact: Jörg Schneemann <[joerge.schneemann@forwind.de](mailto:joerge.schneemann@forwind.de)>



# RAVE Conclusions

RAVE has achieved its goals:

- Proven the offshore-capability of the 5 MW turbine class
- Facilitated further development of offshore wind technology
- Improved the knowledge about offshore wind power

RAVE will continue, but the focus will move:

- Further use of valuable measurement data for research projects
- from design and erection to operation and maintenance
- from demonstration to research



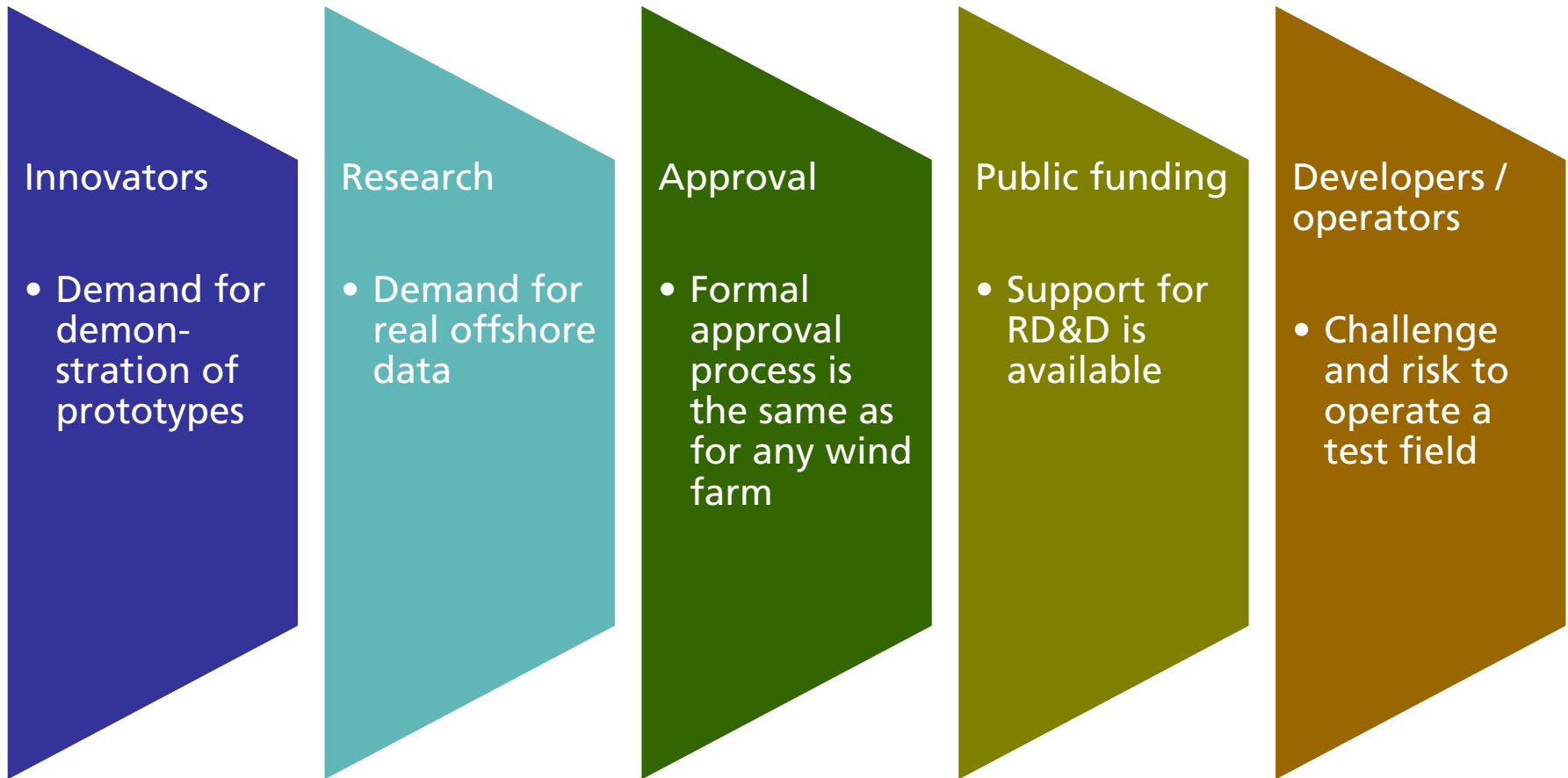
# Test site research beyond RAVE

- Aim of alpha ventus was to pioneer offshore wind power in Germany and to kick-start the development
- Now challenges are:
  - Reduction of technical risks
  - Reduction of cost of electricity
- New offshore test fields are needed for RD&D





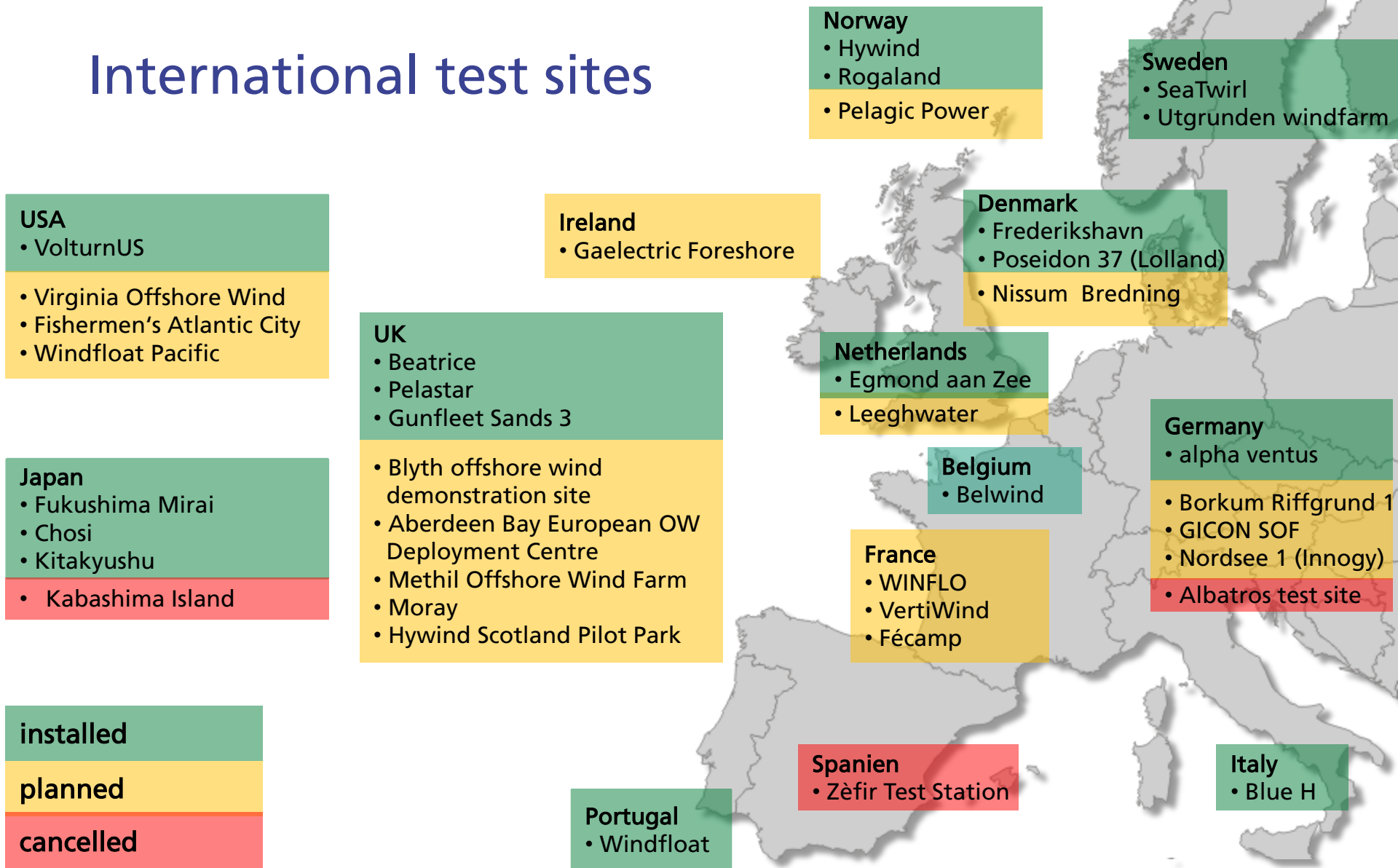
# Initialisation of test fields - stakeholders



# Situation for developers / operators

- Technical risks: Less reliable turbines may cause reduced return as well as expensive maintenance
- Project management risks: Additional coordination as well as scheduling issues
- Economic risks: Higher costs due to small number of turbines and higher risks
- Approval risk: Approval of changes for the test field are required, which may cause delay

# International test sites





# Conclusions

- alpha ventus successfully helped in starting the German offshore development
- RAVE greatly improved the German research capabilities
- To continuously develop the industry, technology and knowledge, continuous offshore test field capacities for RD&D are necessary
- Main challenge is the low attractiveness to develop, own and operate offshore test fields
- A coordination of the efforts in Europe and worldwide would be beneficial

# ... Thanks for your attention!

[WWW.RAVE-OFFSHORE.DE](http://WWW.RAVE-OFFSHORE.DE)

[WWW.OFFSHORE-TESTFELD.DE](http://WWW.OFFSHORE-TESTFELD.DE)

- Information about the projects
- All publications of the projects as download



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