

# Joint test field research – Selected results from the RAVE initiative

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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
  - Research logistics / DNV GL
3. Conclusions

## Acknowledgements:

Bettina Kühn



Jörg Schneemann



Robert Vasold



# 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)



# 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 :



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2014/01/23 DeepWind 2014, Trondheim, Norway

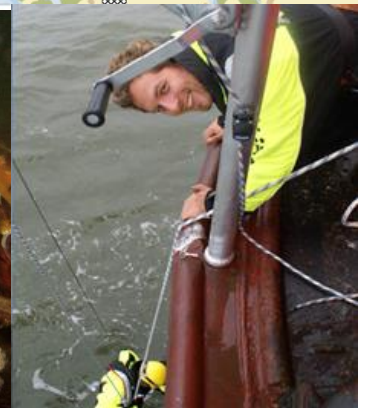


# Main objectives of RAVE

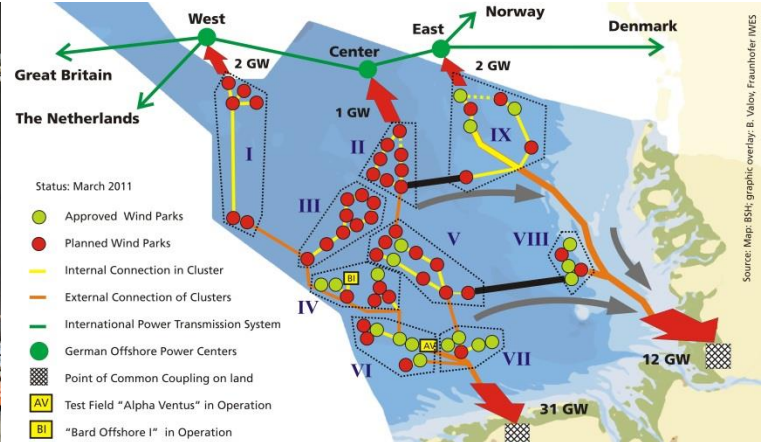
## Demonstration



## Development



## Investigation of OWP issues

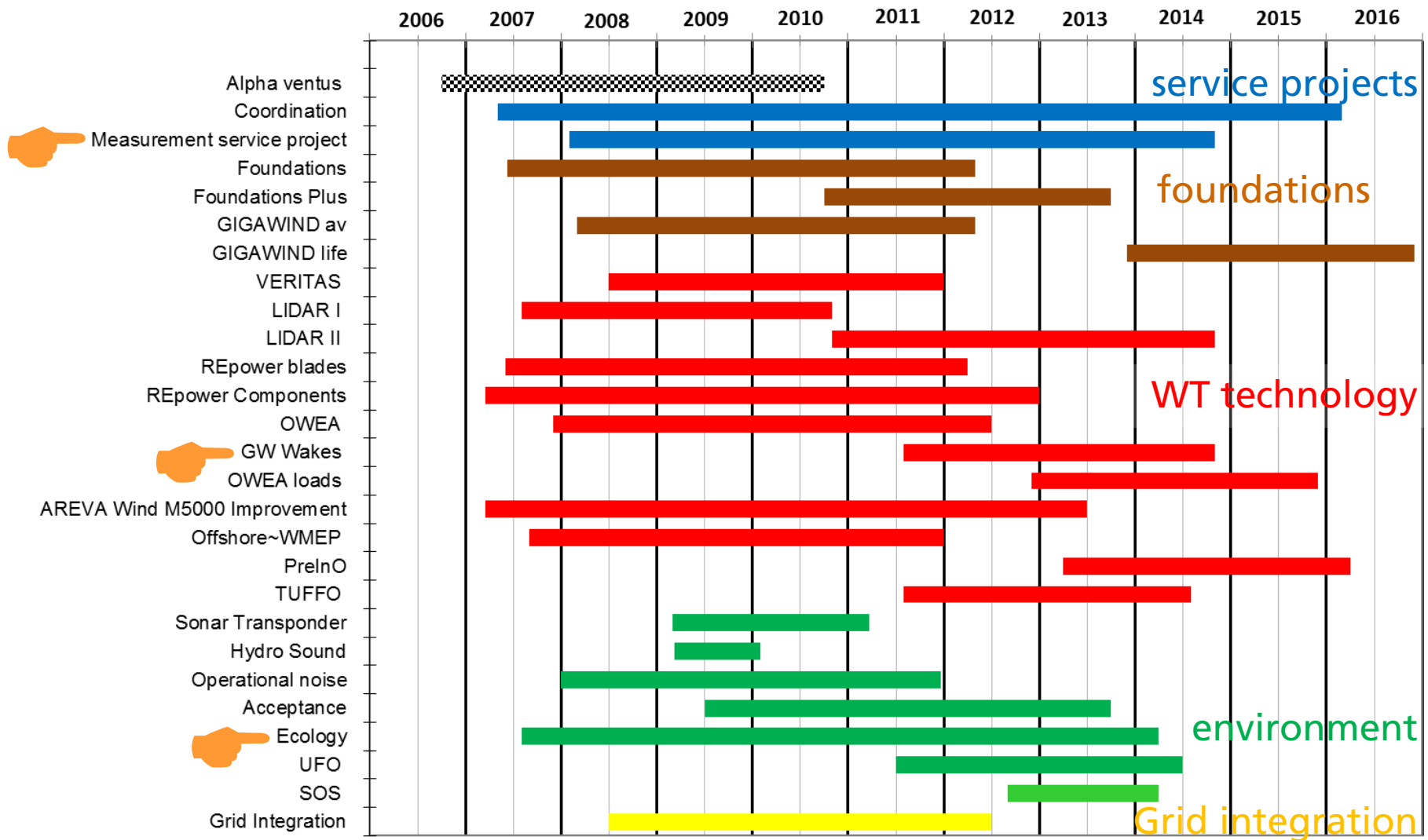


## Expand research, experience & expertise

© DOTI 2009; Boris Valov, Fraunhofer IWES; DEWI; Sebastian Fuhrmann; Fraunhofer IWES

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# RAVE – projects, timelines and research topics



# RAVE – measurements

~ 1,200 sensors

■ strain gauges

■ acceleration

■ acoustic sensors

■ hydrographic sensors

■ met data (sonic, lidar)

■ sonars

■ water pressure sensors

■ SCADA

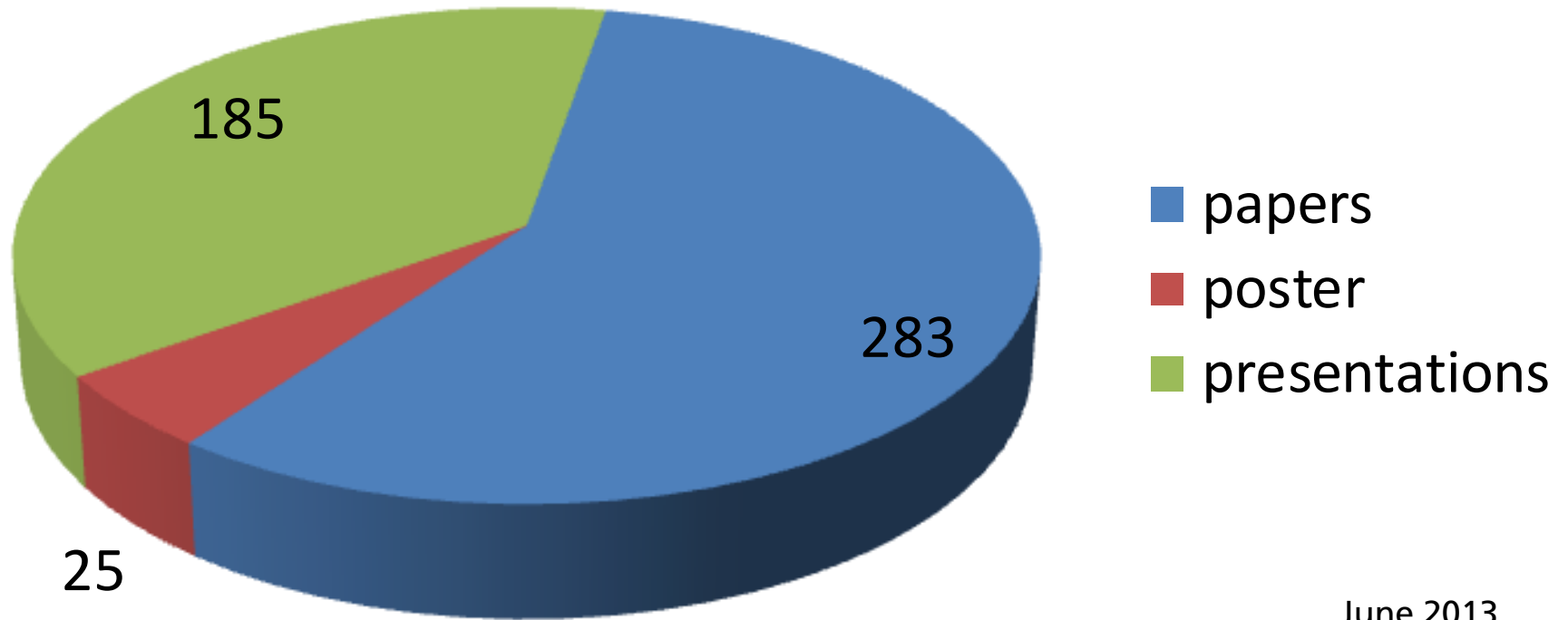
■ corrosion

👁 video cam, radar





# RAVE publications



June 2013





# 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

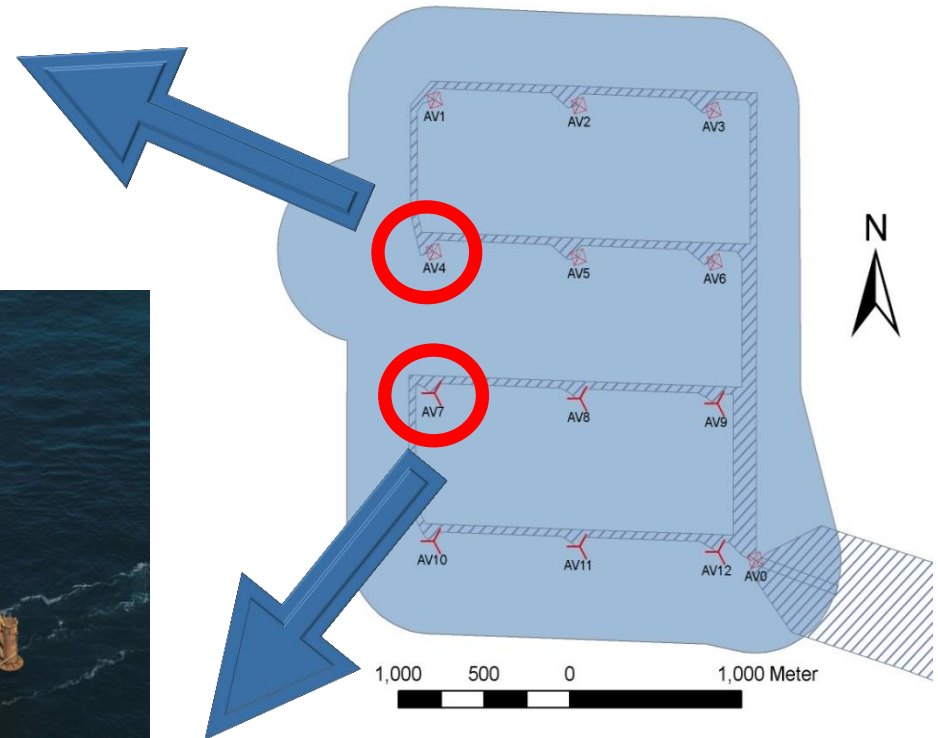
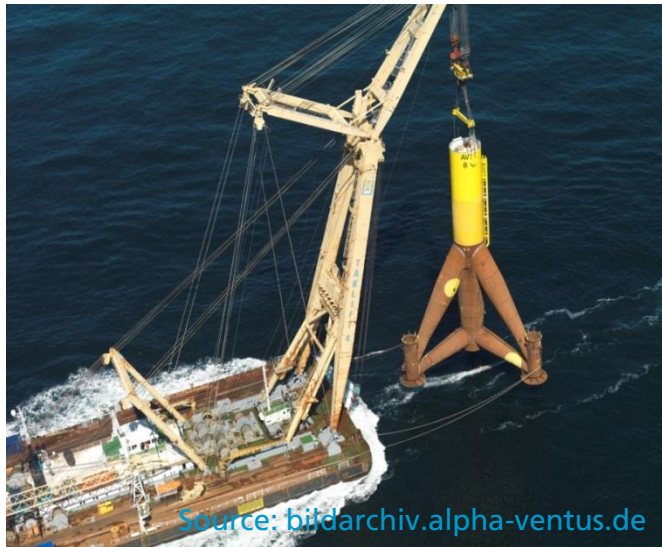


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# The *alpha ventus* test site

Source: BSH, B. Kühn



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# The monitoring concept for scour development at *alpha ventus*

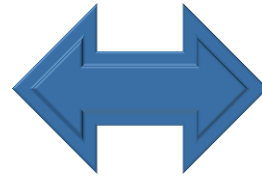
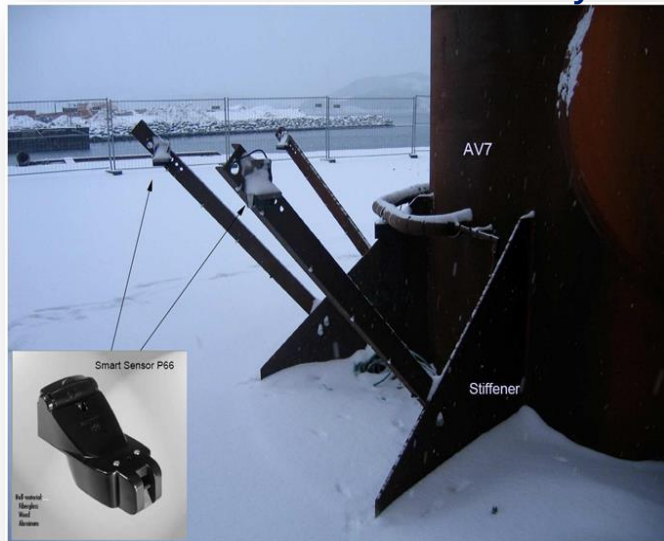
Source: BSH, B. Kühn

## Single Beam

Echosounder

Continuous measurement

since 25.08.2009 until today



## Multibeam

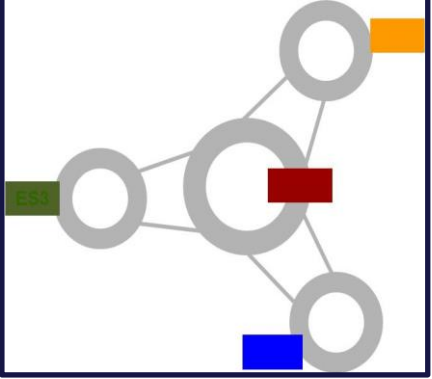
Echosounder

5 surveys which serve as snapshots

since April 2009



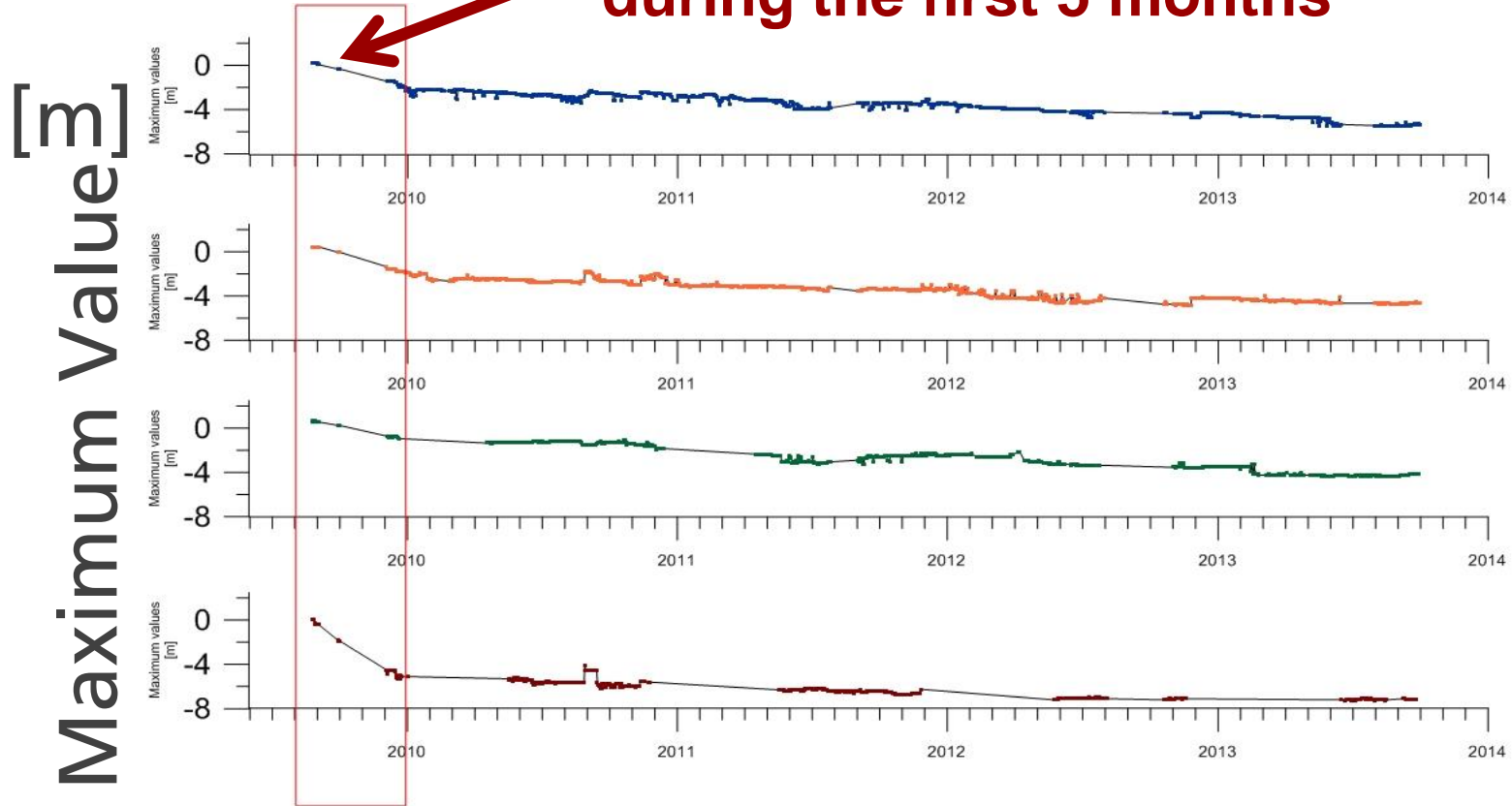




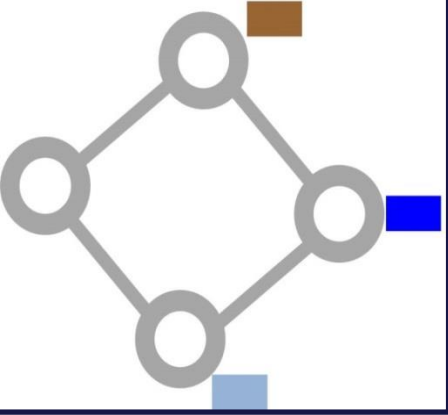
# Development of scour depth in time

Source: BSH, B. Kühn

**rapid increase of the scour during the first 5 months**





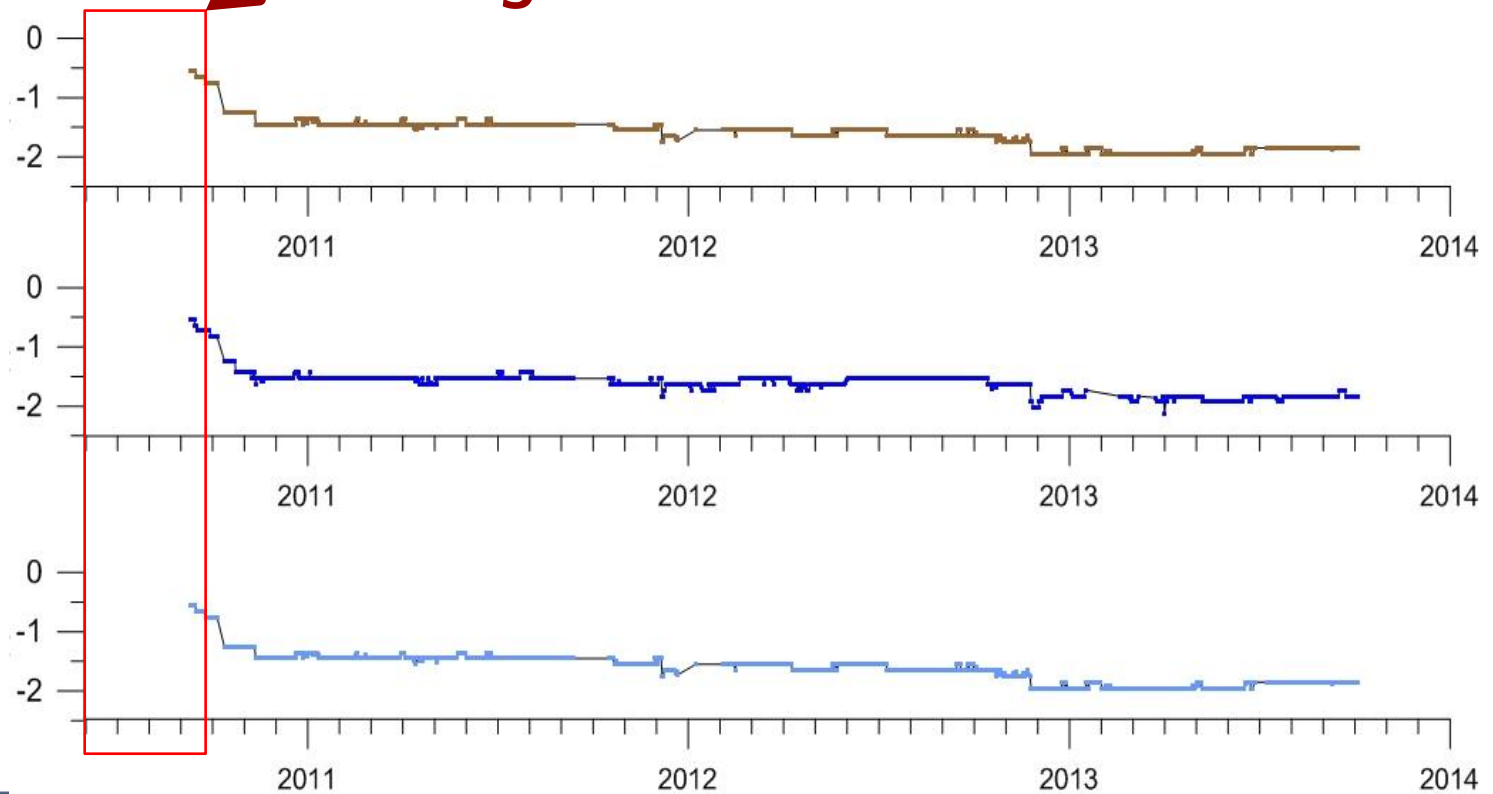


# Development of scour depth in time

Source: BSH, B. Kühn

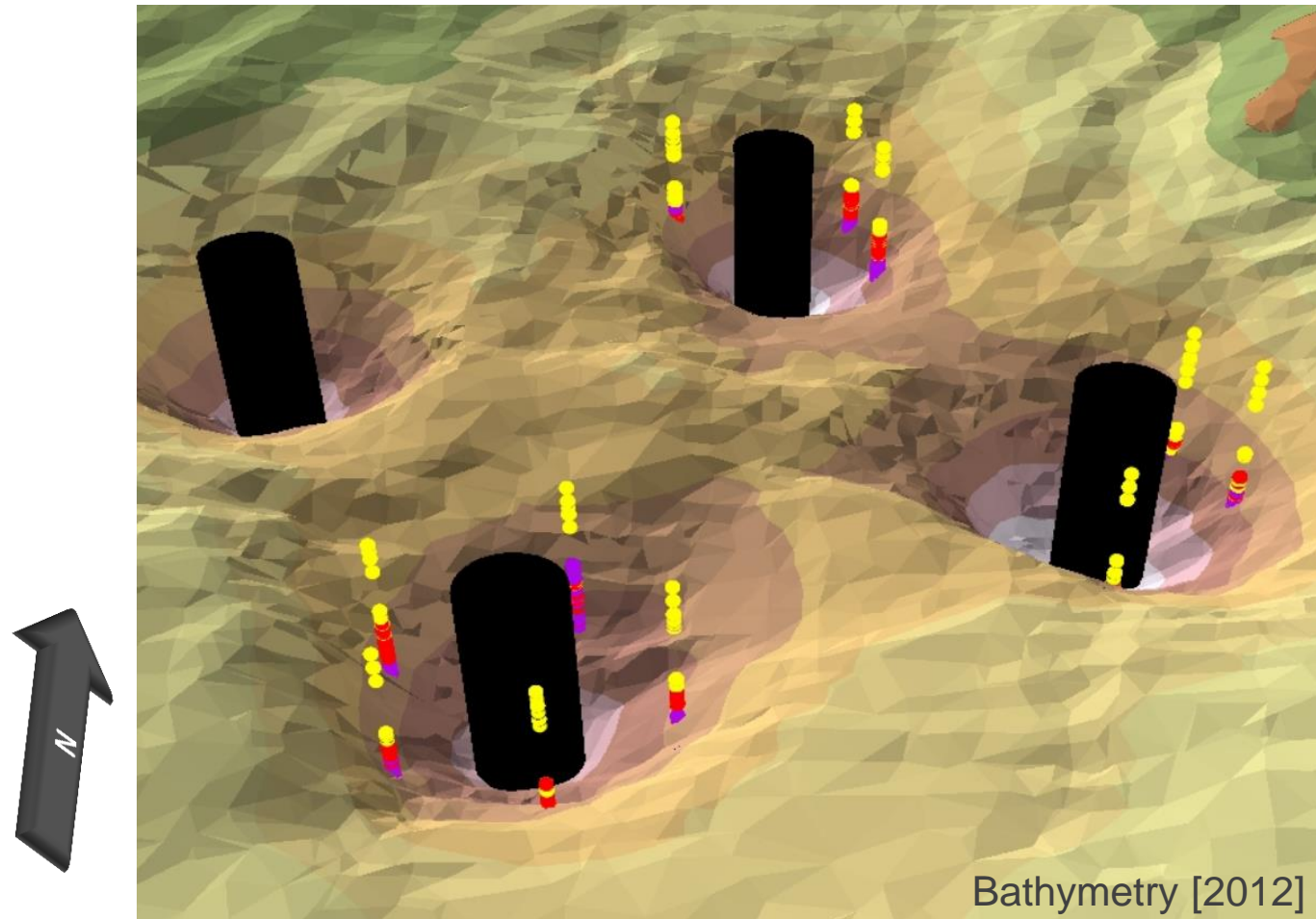
**rapid increase of the scour  
during the first 3 months**

[m]  
Maximum Value



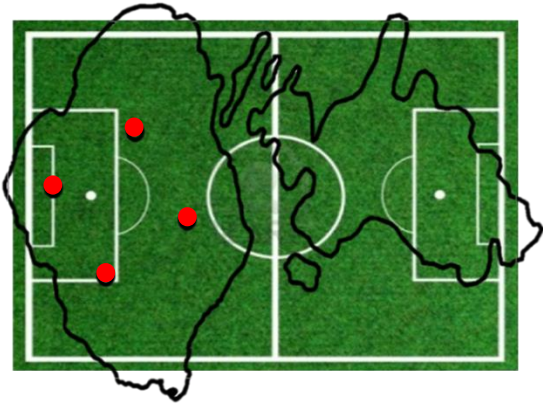
# Development of the scour between 2010 and 2012

Source: BSH, B. Kühn



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# 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>

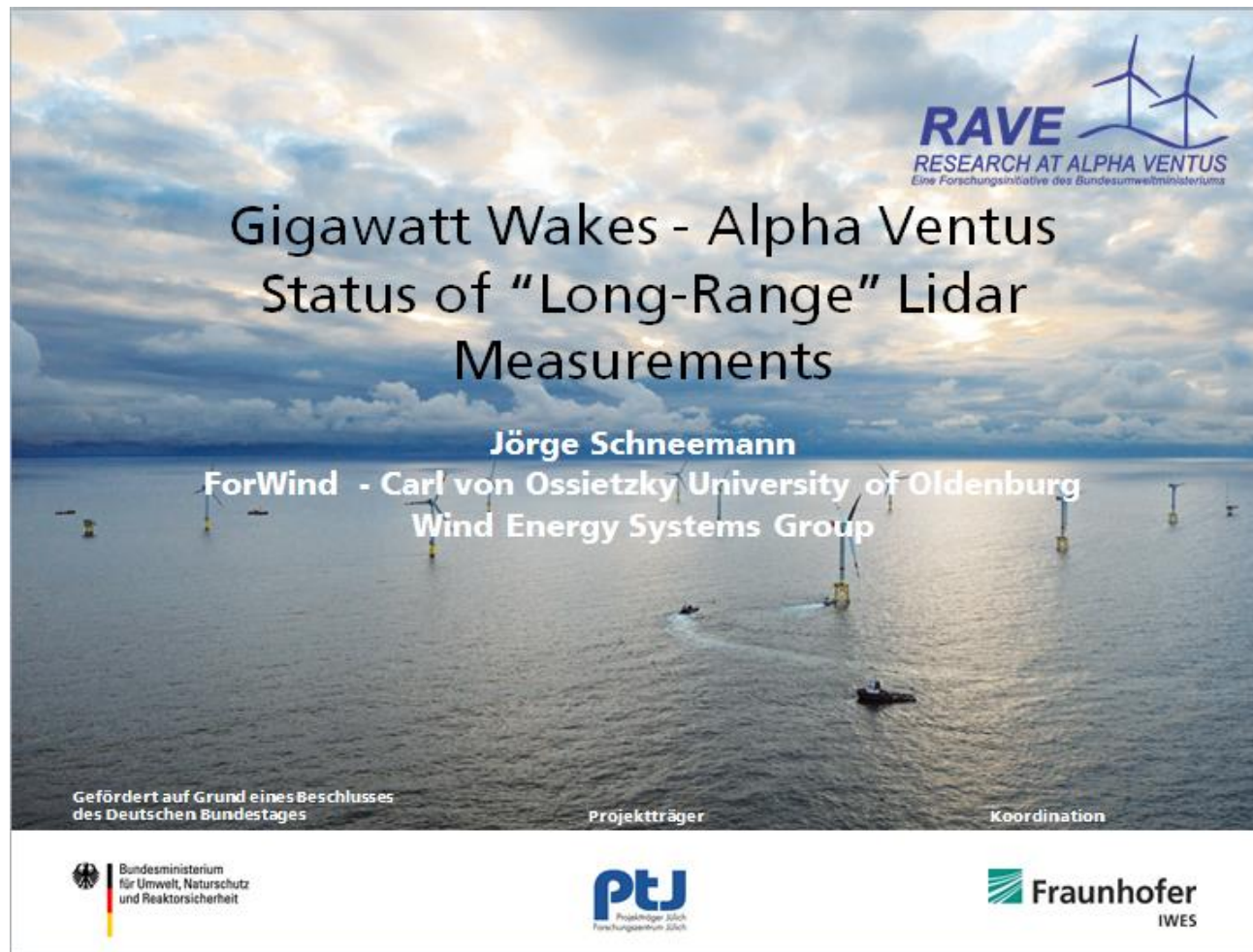
accumulation volume: 200 m<sup>3</sup>  
accumulation area: 1400 m<sup>2</sup>

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


**Jörge 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

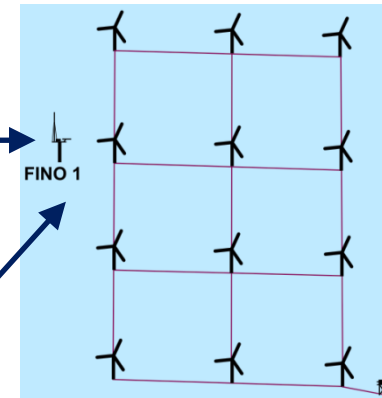
 PTJ  
Projektträger Jülich  
Forschungszentrum Jülich

 Fraunhofer  
IWES

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2014/01/23 DeepWind 2014, Trondheim, Norway



# Long range lidars in alpha ventus



Location	Lidars
FINO 1	2 x WLS200S
Substation	1 x WLS200S



# Long range lidar WindCube WLS200S V1.1

- Pulsed Doppler lidar with “all sky” scanner
- Various possible settings (pulse length, range gate length and position, averaging time,...) → lidar could be well adapted to current task
- Maximal performances (dependent on settings and atm. conditions):
  - Range: 50 – 8000 m
  - Spatial resolution: 25 m
  - Temporal resolution: 240 range gates @ 10Hz
  - Velocity resolution: 0.1 m/s
  - Positioning/ accuracy:  $0.1^\circ$  /  $0.01^\circ$
  - Scenarios: VAD, DBS, RHI, PPI, staring, “complex trajectory”

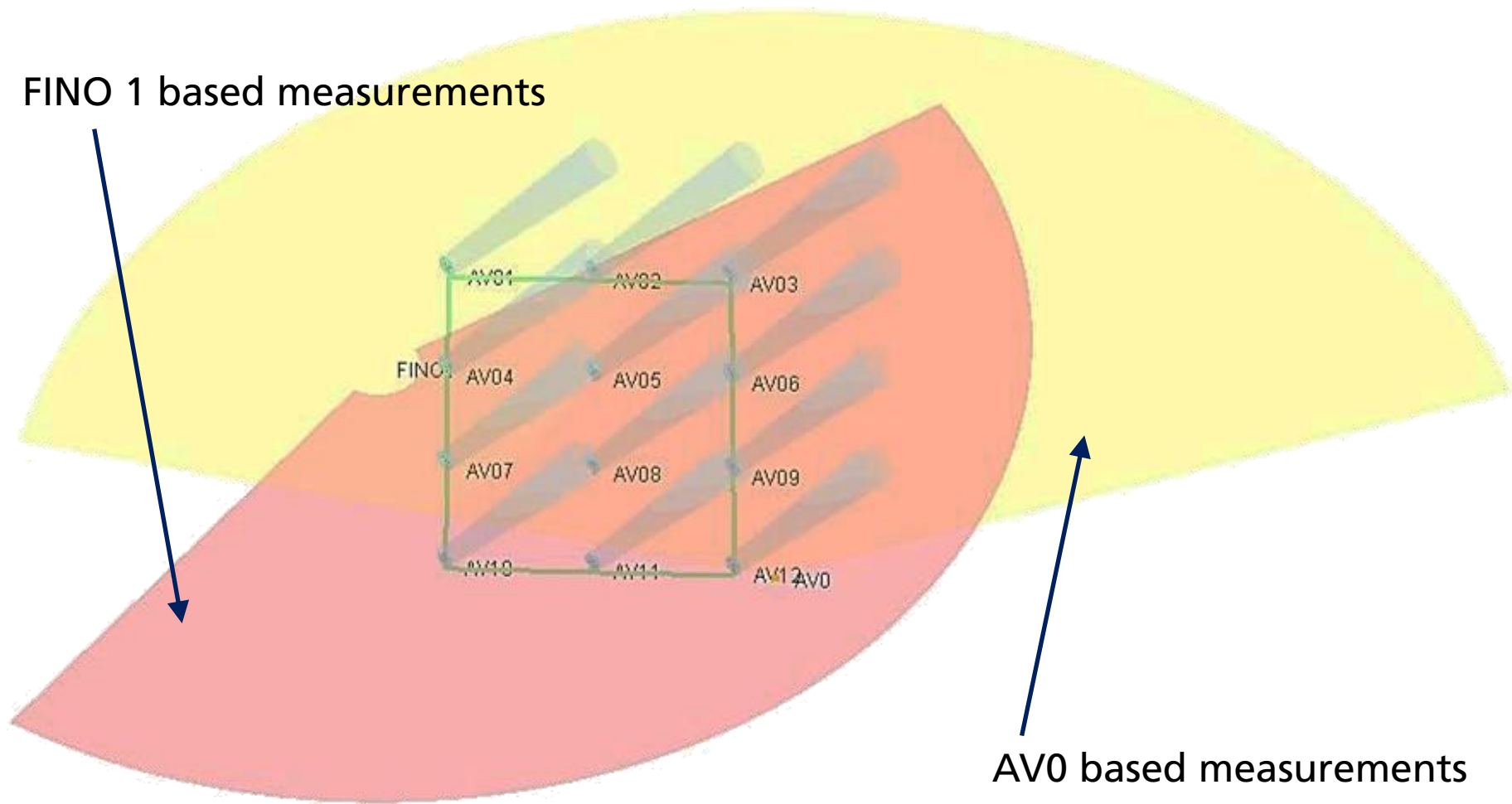


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# Example of „long-range“ measurements

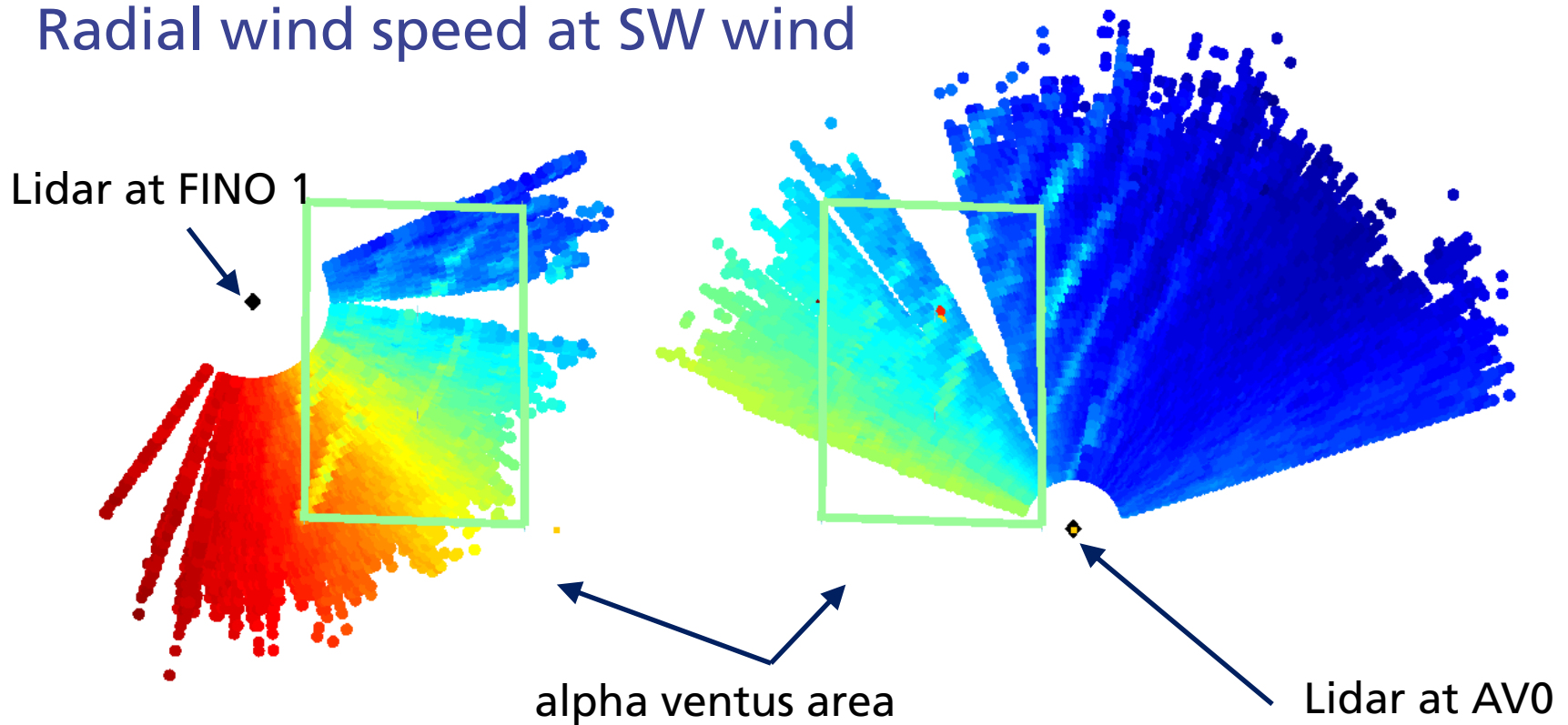
## Scan of azimuth at constant elevation

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  
⇒ “Remote met tower”  
⇒ Comparison to floating / ship lidar of FHG-IWES

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



# Selected results (3)



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RESEARCH AT ALPHA VENTUS  
Eine Forschungsinitiative des Bundesumweltministeriums

## RAVE logistics

**Robert Vasold**  
**DNV GL**

Gefördert auf Grund eines Beschlusses  
des Deutschen Bundestages

Projektträger

Koordination

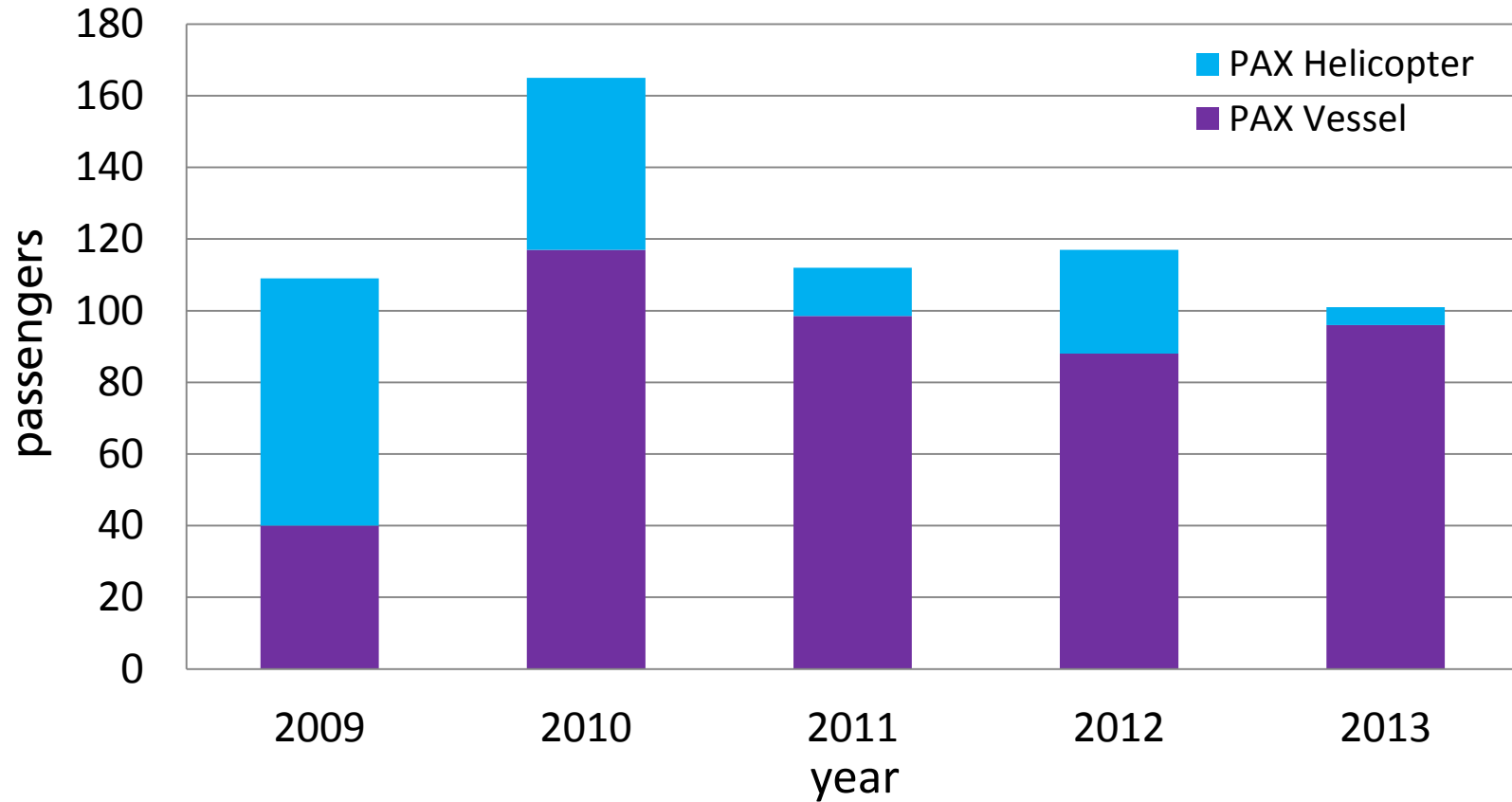
 Bundesministerium  
für Umwelt, Naturschutz  
und Reaktorsicherheit

 **PTJ**  
Projektträger Jülich  
Forschungszentrum Jülich

 **Fraunhofer**  
IWES

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# Transportation of RAVE personnel



Source: DNV GL / Robert Vasold

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# Logistics: Main Issues and bottlenecks

- Weather and port restrictions
- PAX capacity bottlenecks
- Technical problems
- Work task priorities
- Limitations of accompanying personal
- HSE qualifications



Source: DNV GL / Robert Vasold

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# Summary

- Alpha ventus performs good
- Successful research cooperation
- New findings achieved
- New questions arose
- Further R&D is needed
- Increasing 3<sup>rd</sup>-party interest on data

