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– NEOWIND Project – Next Generation of Offshore Wind Lidar Measurements

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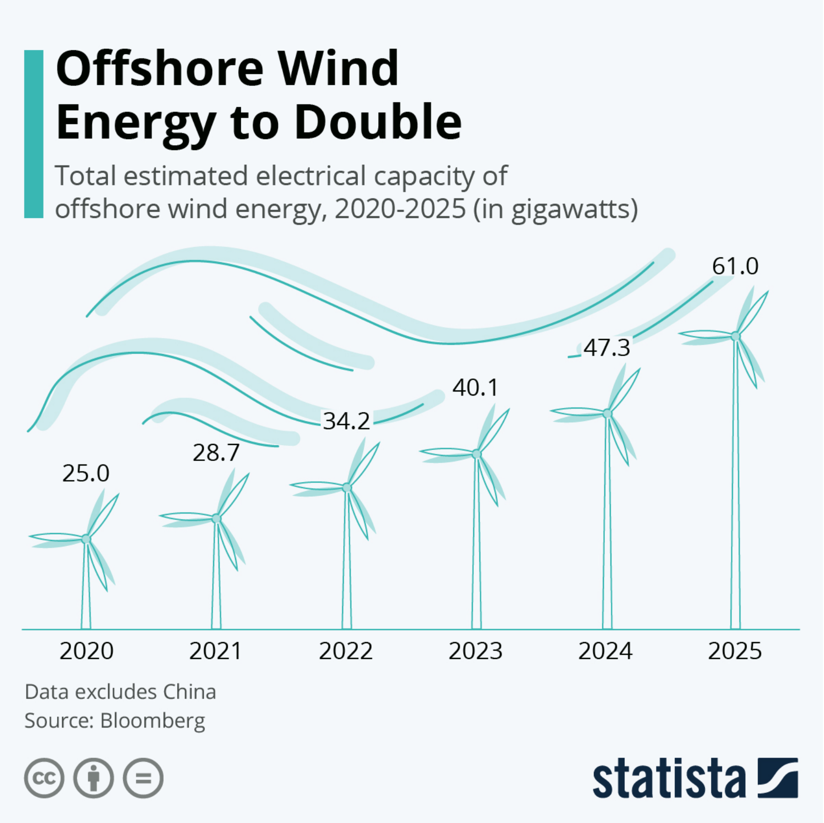
WINDFORS Windenergie Forschungscluster

Background and Motivation



Ref.: https://www.statista.com/chart/23334/offshore-global-wind-energy-estimates/

Challenges for floating lidar systems

- Reliability in marine environments
- Influence of wave-induced motion

R&D Project NEOWIND: 01.08.2022 - 31.07.2024

Project Consortium

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- The first university chair for wind energy in Germany
- Covering a wide range of research topics: lidar measurement techniques, turbine control, offshore load analysis and full-scale data validation, floating wind turbine dynamics, design and standardization, social acceptance, and optimization of grid integration, etc.

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- Offering a combination of wind, ocean and environmental turn-key measuring solutions and digital services to the offshore wind industry
- EOLOS' product, the FLS200, is a multi-purpose, autonomous buoy that integrates cutting edge sensors to measure wind, ocean and environmental characteristics reducing uncertainty and inherent risks during the development, operation and maintenance phase of the offshore wind farm.

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- An engineering consultancy, with its main business fields in lidar technology, floating wind and control applications.
- The team of sowento has a strong background in developing advanced lidar-based applications, as well as a profound knowledge in the modeling, control, and analysis of floating wind turbines.

Project Objectives

Developing a lidar modular system for enhanced offshore wind measurements

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Real-time motion compensation software

Advance methods for TI estimation from floating lidar measurements

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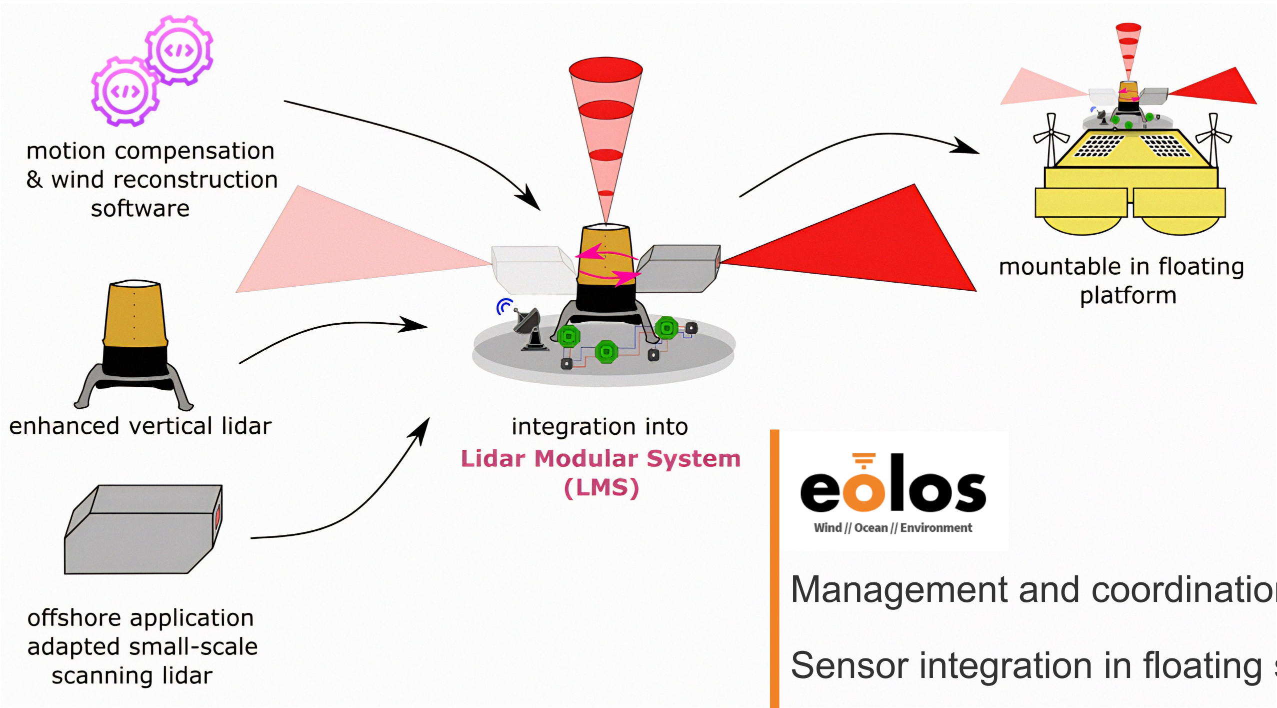
Offshore prototype of the SWE lidar scanners

Motion adaptive mode for the SWE lidar scanners



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Management and coordination

Sensor integration in floating systems

Tests in real environments

Motion Compensation for Floating Lidars: Motivation

Why TI from floating lidars is different from onshore (static) lidars?

1. They don‘t measure where they think
2. Measurement is superposed with own velocity

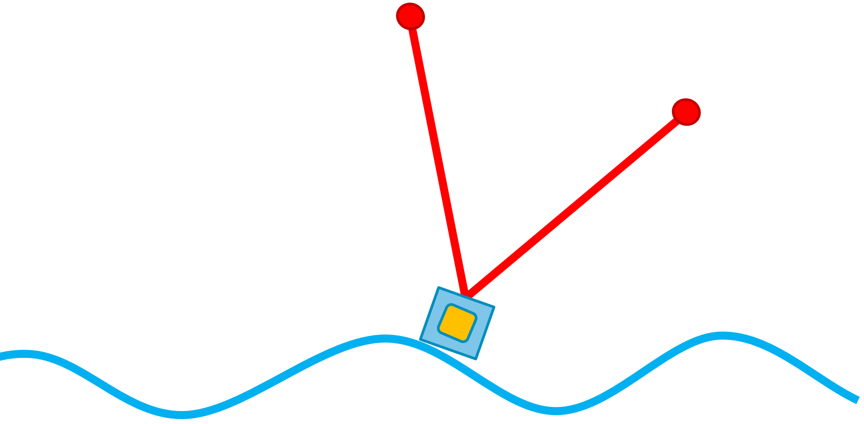
Thus, we can correct the measurement by

1. Estimating the position of measurement
2. Estimating the lidar speed with an inertial measurement unit (IMU)

Motion Compensation for Floating Lidars: Approach

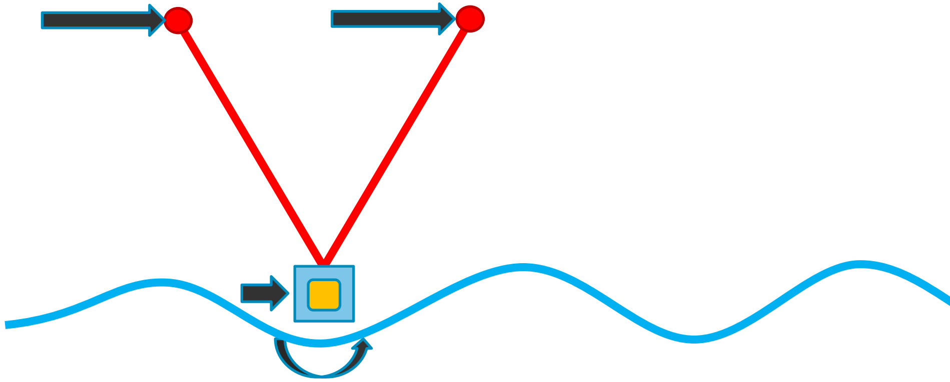
Estimating the position of measurement

- Effect influence the wind field reconstruction
  Ⓟ Assumption of same measurement height violated



Estimating the lidar speed

- Effect directly influence the line-of-sight measurements
  Ⓟ Superposition of motions



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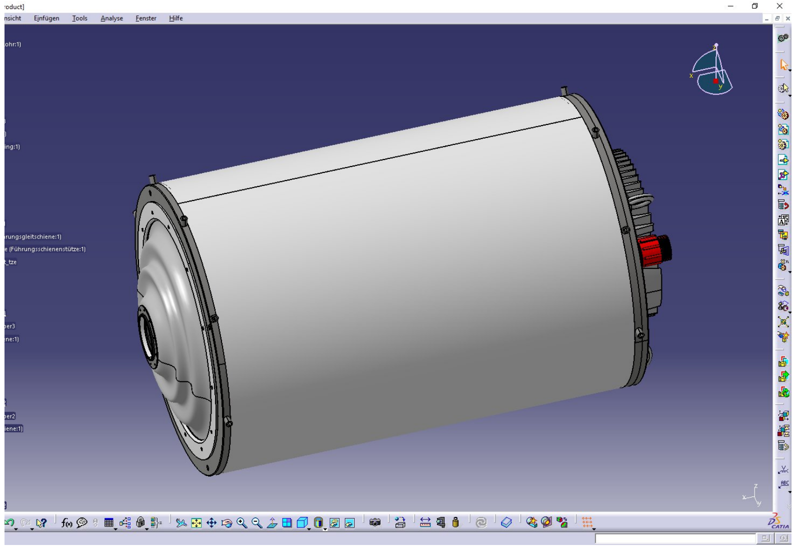
Offshore Prototype of the SWE Scanning Lidars

Objective

- Offshore-ready (robust, reliable) scanning lidar prototype (Hardware)
- Ready for integration into a modular offshore measurement concept (Hardware + Software)

Conception

- Design and hardware development as well as the manufacturing and the integration of a small-scale offshore Scanning Lidar
- Focus on lightweight design methods and materials (e.g., carbon fiber).
- Reliability analysis of major components
- Motion system tests and measurement campaigns

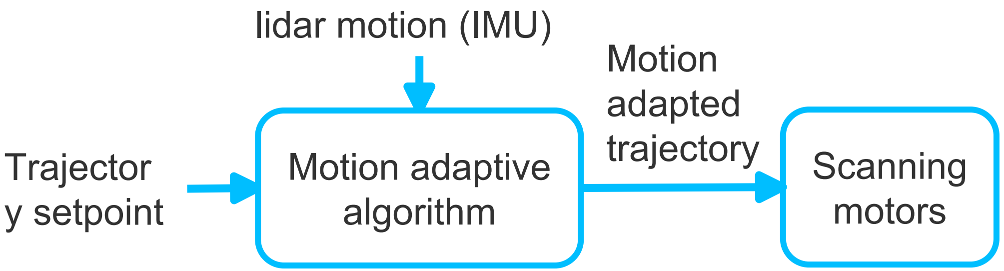


(Onshore version of SWE Scanning Lidar 2.0)

Motion Adaptive Mode for the SWE Scanning Lidars

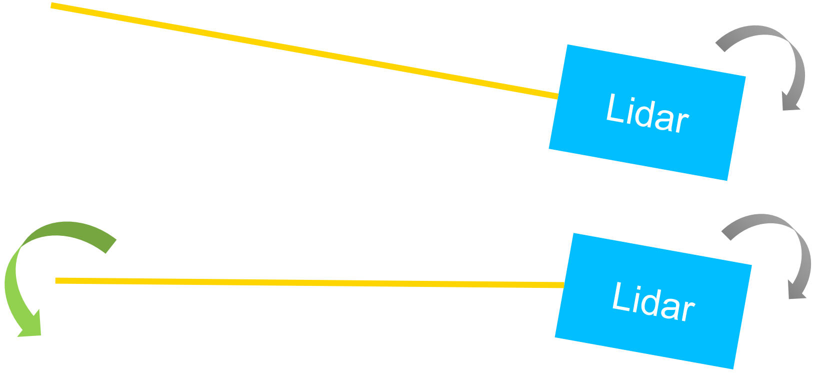
Objective

- Reducing the influence of the rotational motion of the lidar on the lidar measurements by correcting the trajectory setpoints using the IMU measurements.



Conception

- Implementing the motion adaptive algorithm as a Demo program in LabVIEW
- Testing the Demo program with simulations
- Integrating the live data streaming from the IMU into the Demo program
- Validating the Demo program with experimetal tests on a 6-DOF motion system



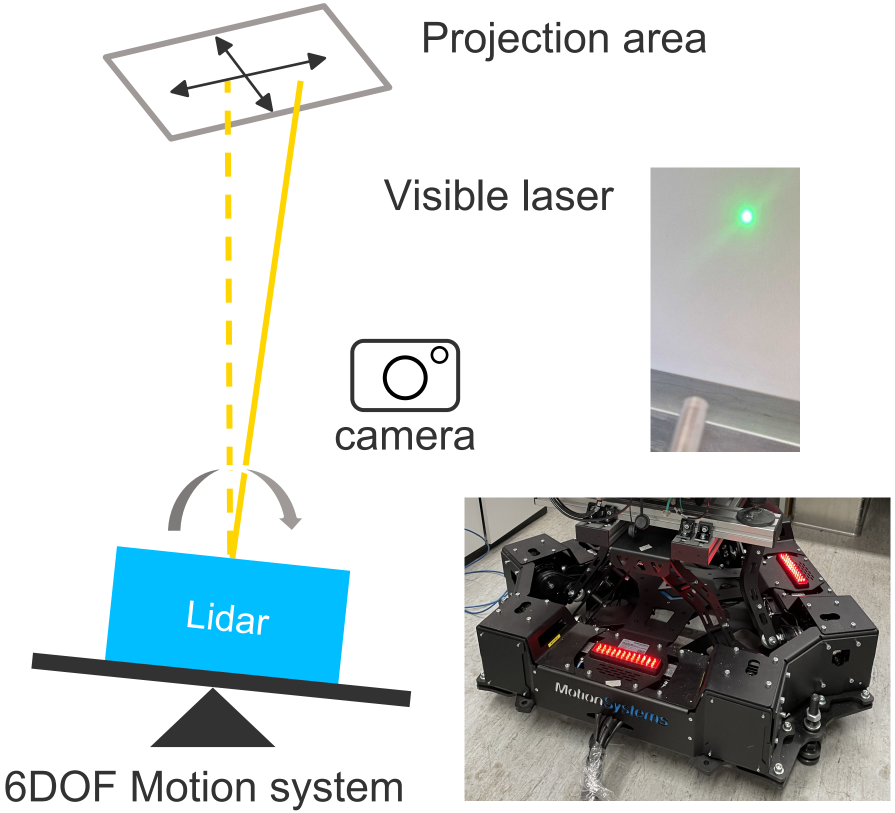
Ref.: Yiyin Chen et al 2022 J. Phys.: Conf. Ser. 2265 022099, https://doi.org/10.1088/1742-6596/2265/2/022099

Sensor Integration in Floating Systems

- Matching the specifications of the vertical lidar and the FLS200 buoy for the integration of the innovative motion compensation method developed by sowento
- Validation tests to be performed on a SWE motion system
- Knowledge gathered regarding flow reconstruction, data management and computation on-board transferred to marinized scanning lidar development
- Expected outcome: Integration and synergies obtained from flow reconstruction, floating systems, and scanning lidar technologies

Experimental Tests with a 6-DOF Motion System

- 6-DOF movements: pitch, roll, yaw, surge, sway, and heave.
- Modeling the movements of a floating platform under different wave conditions.
- Tests will be carried out with the experimental setup:
  - Reliability tests of the offshore prototype of the SWE scanning lidars
  - Validation of the motion adaptive mode for the SWE scanning lidars
  - Validation of the motion compensation algorithm for floating lidars.



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Summary and Outlook

Project Goal: Lidar Modular System

The lidar modular system will provide an important amount of wind data with an unprecedented accuracy, reducing the levels of uncertainty for the offshore wind farm and becoming a breakthrough for the offshore wind energy industry.

Expected Main Outcomes

- Offshore-ready scanning lidar prototype
- Motion adaptive mode for the scanning lidar
- Motion compensation algorithm for the vertical lidar
- Integration into the floating system

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Thank you!

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